U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

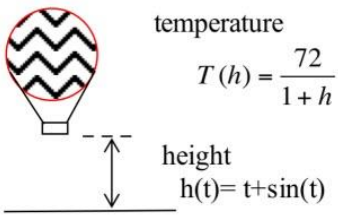
Autonomous Institute Affiliated to VTU

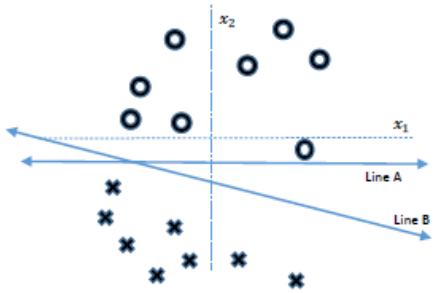
June 2025 Semester End Main Examinations

Programme: B.E. **Semester: V**
Branch: Artificial Intelligence and Machine Learning **Duration: 3 hrs.**
Course Code: 23AM5HSCSM **Max Marks: 100**
Course: Calculus and Statistics for Machine Intelligence

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - I	CO	PO	Marks
1	a)	Assume that you are riding in a balloon, and at time t (in minutes) you are at $h(t) = t + sin(t)$ feet high. If the temperature at an elevation h is $T(h) = \frac{72}{1+h}$ degrees Fahrenheit, how fast is your temperature changing when $t = 5$ minutes?  Fig. 2	CO 1	PO 2	**10**
	b)	If $x = r\sin\theta\cos\phi, y = r\sin\theta\sin\phi$ and $z = r\cos\theta$, then find the Jacobian $\frac{\partial(x,y,z)}{\partial(r,\theta,\phi)}$	CO 1	PO 1	**10**
		OR			
2	a)	Using the first order principle, find the derivative of cos(x)	CO 1	PO 1	**08**
	b)	Evaluate $\int \frac{3x^2+12x+11}{(x+1)(x+2)(x+3)}\,dx$.	CO 1	PO 1	**06**
	c)	Find the curve of steepest descent for the ellipsoid $4x^2 + y^2 + 4z^2 = 16, z \geq 0$	CO 1	PO 1	**06**
		UNIT - II			
3	a)	Write a short note on Advantages and limitations of best subset selection.	CO 2	PO 1	**05**

<table>
<tr><td></td><td></td><td>b)</td><td>Given database and predictor model $y = 18.005 + 0.39x_1 - 0.623x_2$
<table>
<tr><td>X1</td><td>6</td><td>8</td><td>9</td><td>11</td><td>15</td><td>17</td></tr>
<tr><td>X2</td><td>13</td><td>10</td><td>6</td><td>4</td><td>2</td><td>2</td></tr>
<tr><td>y</td><td>28</td><td>22</td><td>18</td><td>12</td><td>8</td><td>2</td></tr>
</table>
Calculate R^2 and adjusted R^2</td><td>CO 2</td><td>PO 1</td><td>07</td></tr>
<tr><td></td><td></td><td>c)</td><td>Differentiate between ridge and lasso regression.</td><td>CO 2</td><td>PO 1</td><td>08</td></tr>
<tr><td></td><td></td><td></td><td>OR</td><td></td><td></td><td></td></tr>
<tr><td>4</td><td>a)</td><td>Explain the subset selection method of linear regression along with the associated challenges and possible solutions.</td><td>CO 2</td><td>PO 1</td><td>10</td></tr>
<tr><td></td><td>b)</td><td>Given feature X with values 3,4,5,6,7 and the target variable Y with values 4,6,8,10 12 Compute the ridge regression coefficients, for $\lambda = 2$</td><td>CO 2</td><td>PO 1</td><td>10</td></tr>
<tr><td></td><td></td><td>UNIT - III</td><td></td><td></td><td></td></tr>
<tr><td>5</td><td>a)</td><td>Differentiate between L1 and L2 regularization.</td><td>CO 2</td><td>PO 1</td><td>05</td></tr>
<tr><td></td><td>b)</td><td>In the given training set, each data point has two features - one on the horizontal axis and the second on the vertical axis. Each point is in one of two classes: ’X’ (class 1), ’O’ (class −1).


i. Line A is on the horizontal axis with an intercept of −1. Line B has a slope of −1/2 and an intercept of −2 on the vertical axis. Find the possible values of w to produce line A and line B.
ii. For the w found in (i), show that $2w$ still corresponds to the same separating hyperplane (i.e. to the same lines A and B).</td><td>CO 2</td><td>PO 3</td><td>07</td></tr>
<tr><td></td><td>c)</td><td>Derive the maximum likelihood estimator for a logistic regression model.</td><td>CO 2</td><td>PO 1</td><td>08</td></tr>
<tr><td></td><td></td><td>OR</td><td></td><td></td><td></td></tr>
<tr><td>6</td><td>a)</td><td>Derive the mathematical formulation of logistic regression and the sigmoid function.</td><td>CO 2</td><td>PO1</td><td>07</td></tr>
<tr><td></td><td>b)</td><td>The dataset of Pass or fail in an exam of 5 students is given in the table
<table>
<tr><td>Hours study</td><td>29</td><td>15</td><td>33</td><td>28</td><td>39</td></tr>
<tr><td>Pass(1)/fail(0)</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td></tr>
</table>
Use logistic regression as classifier to answer</td><td>CO 2</td><td>PO 2</td><td>08</td></tr>
</table>

		i. Calculate the probability of pass for the student who studied 33 hours. ii. At least how many hours student should study that makes he will pass the course with the probability more than 95%. By assuming $\log(odds) = -64 + 2 * hours$.			
	c)	Elaborate the importance of regularization in Machine Learning.	*CO 1*	*PO 1*	**05**
		UNIT - IV			
7	a)	Solve the given Linear Programming Problem (LPP) graphically. Maximize: Z = 8x + y Subjected to the constraints: x + y = 40, 2x + y = 60, x ≥ 0, y ≥ 0	*CO 3*	*PO 2*	**06**
	b)	Maximize the function $u = 4x^2 + 3xy + 6y^2$ using Lagrange multiplier, subjected to the constraint $x + y = 56$	*CO 3*	*PO 3*	**07**
	c)	For the given actual and predicted values of a regression problem, compute the Mean Absolute Error (MAE), Mean Squared Error (MSE), and Root Mean squared Error (RMSE).	*CO 3*	*PO 1*	**07**
		OR			
8	a)	Dorian company makes luxury cars and jeeps for high-income men and women. It wishes to advertise with 1 minute spots in comedy shows and football games. Each comedy spot costs $50K and is seen by 7M high-income women and 2M high-income men. Each football spot costs $100K and is seen by 2M high-income women and 12M high-income men. How can Dorian reach 28M high-income women and 24M high-income men at the least cost? [Note: Solve the stated problem using graphical method]	*CO 3*	*PO 3*	**06**
	b)	Find the critical points of the function $f(x, y) = 2x^3 - 3x^2 y - 12x^2 - 3y^2$ and determine their type i.e. local min/local max/saddle point.	*CO 3*	*PO 3*	**07**
	c)	Find the maximum and minimum based on hessian matrix of the function $f(x, y, z) = x^3 + y^3 + z^3 - 9xy - 9xz - 27x$	*CO 3*	*PO 1*	**07**
		UNIT - V			
9	a)	Consider the following data D1 : [I am], [am Sam] D2 : [Sam I], [I am] D3 : [I do], [do not], [not like], [like green], [green eggs], [eggs and], [and ham] D4 : [I do], [do not], [not like], [like them], [them Sam], [Sam I], [I am] Find the Jaccard similarity of the following: i) JS(D1,D2) ii) JS(D1,D3) iii) JS(D1,D4) iv) JS(D2,D3) v) JS(D2,D4) vi) JS(D3,D4)	*CO 3*	*PO 2*	**06**

Actual values	250	110	500	200	330	490	670	210
Predicted values	265	140	480	215	290	515	750	210

		b)	User recommendations for the movies are documented below. With the help of collaborative filtering based similarity measure, analyze the records and conclude your observations accordingly. User | Movie1 | Movie2 | Movie3 | Movie4 User 1 | 5 | 4 | | User 2 | 4 | | 3 | User 3 | | 1 | | 2 User 4 | 1 | 2 | |	*CO 3*	*PO 2*	**07**
		c)	For the vectors $X = [1,2,-1] and\ Y = [2,1,1]$ in the Euclidian space, find i. Similarity between X and Y ii. Jaccard distance iii. Cosine distance	*CO 3*	*PO 1*	**07**
			OR			
	10	a)	Calculate the Edit distance between strings $X = A\ B\ C\ D\ E\ and\ Y = A\ C\ F\ D\ E\ G$ using i. LCS method (Longest common subsequence method) ii. Classical method	*CO 3*	*PO 1*	**06**
		b)	The points (1,2,2) and (2,5,3) are in 3D Euclidian space. Compute $L_1\ and\ L_2\ norms$.	*CO 3*	*PO 1*	**07**
		c)	Customer rate the movies between 1 and 5, where 1- Least likely, 5- Most likely. Using collaborative filtering, find M5 of Customer 1. **Movies / Customer** | **M1** | **M2** | **M3** | **M4** | **M5** Customer 1 | 5 | 3 | 4 | 4 | **??** Customer 2 | 3 | 1 | 2 | 3 | 3 Customer 3 | 4 | 3 | 4 | 3 | 53 Customer 4 | 3 | 3 | 1 | 5 | 4 Customer 5 | 1 | 5 | 5 | 2 | 1	*CO 3*	*PO 1*	**07**

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