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Odd Semester Examination-2024

Paper Name: Mathematics for Machine Learning & AI
Paper Code: BTCSE (AI)-311

Maximum Marks: 60
Time: 2.5 Hours

NOTE: Programmable calculator is not allowed.

PART -A
(All questions are compulsory)

(4 X 5 = 20)

S.No	Questions	Marks	CO	BL
Q.1	Define a subspace of a vector space. Let W_1 and W_2 be two subspace of a vector space V . Show that $W_1 \cap W_2$ is a subspace of V .	5	CO1	L2
Q.2	Obtain a basis for the subspace $W = \{(x, y, z) \mid x+y+z=0\}$ of the vector space $\mathbb{R}^3$ and hence find its dimension.	5	CO1	L3
Q.3	Compute the Hessian matrix of the function $f: \mathbb{R}^3 \rightarrow \mathbb{R}$ defined by $f(x, y, z) = x^2 + 2y^2 + 4z^2 + x + y + z - 2$. Further, using the Hessian matrix show that f is a convex function.	5	CO3	L5
Q.4	Maximize $Z = 2x_1 + 3x_2$ subject to $2x_1 + x_2 + x_3 = 6$ $x_1 + 2x_2 + x_4 = 7$ $x_1, x_2, x_3, x_4 \geq 0$	5	CO4	L4

PART – B

(Attempt any Four Questions out of Six)

(4 X 10 = 40)

S. No	Questions	Marks	CO	BL
Q.1	Let P_2 denotes the vector space of all polynomials of degree less than equal to 2. Define $T: P_2 \rightarrow \mathbb{R}^3$ by $T(a_0 + a_1x + a_2x^2) = (a_2, a_1, a_0)$ for all $p(x) = a_0 + a_1x + a_2x^2 \in P_2$. (i) Show that T is a linear transformation. (ii) Find the range and Kernal of T	10	CO1	L3
Q.2	Find the singular value decomposition of the matrix $A = \begin{bmatrix} 2 & 2 \\ -1 & 1 \end{bmatrix}$	10	CO2	L4
Q.3	Apply the Gram–Schmidt orthogonalization process to obtain an orthonormal basis from the basis $B = \{(1, 2, 0, 1), (2, 0, 1, 0), (0, 1, 2, 1), (1, 1, 1, 1)\}$ of $\mathbb{R}^4$	10	CO2	L4
Q.4	(i) Evaluate the gradient of the function $f: \mathbb{R}^3 \rightarrow \mathbb{R}$ defined by $f(x, y, z) = x^3 - 2xy^2 + y^3 + 3y^2$ at $P = (1, 0, 1)$. (ii) Find the derivative of $f(x, y) = xe^y + \cos(xy)$ at $P = (2, 0)$ in the direction of $3i - 4j$.	10	CO3	L5
Q.5	Use Newton's method to minimize $f(x, y) = 2x^2 + 2xy + y^2 + x - y$. Take initial approximation $X_1 = (0, 0)^T$.	10	CO4	L5
Q.6	Define the following terms: 1. Linearly Separable Margin 2. Canonical Separating Hyperplane 3. Optimal Separating Hyperplane 4. Dead Zone	10	CO5	L1

BL – Bloom's Taxonomy Levels (1- Remembering, 2- Understanding, 3- Applying, 4- Analyzing, 5- Evaluating, 6- Creating)

CO-Course Outcomes

*****End of Paper*****