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BCS405C

Fourth Semester B.E./B.Tech. Degree Examination, June/July 2025
Optimization Techniques

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.

		Module – 1	M	L	C
Q.1	a.	Obtain the partial derivatives $\frac{\partial f}{\partial x}, \frac{\partial f}{\partial y}$ for i) $f(x, y) = (x + 2y^3)^2$ ii) $f(x, y) = x^2y + xy^3$	6	L3	CO1
	b.	Obtain the gradient of scalar $\phi = 4x_0 + 2x_1 - 3x_2 + x_4$ with respect to the matrix.	7	L3	CO1
	c.	Obtain Taylor's series expansion of $f(x, y) = x^2y + 3y - z$ in terms of $(x - 1)$ and $(y + 2)$ upto the third degree terms.	7	L3	CO1
		OR			
Q.2	a.	Discuss the gradient of vector with respect to matrix.	6	L2	CO1
	b.	Find the gradient of matrix $f = \begin{bmatrix} \text{Sin}(x_0 + 2x_1) & 2x_1 + x_3 \\ 2x_0 + x_2 & \text{Cos}(2x_2 + x_3) \end{bmatrix}$ with respect to the matrix $X = \begin{bmatrix} x_0 & x_1 \\ x_2 & x_3 \end{bmatrix}$	7	L3	CO1
	c.	Expand $e^x \cos y$ near the point $(1, \pi/4)$ by Taylor's theorem.	7	L3	CO1
		Module – 2			
Q.3	a.	Construct a computation graph of the function $f(x) = \sqrt{x^2 + e^{x^2}} + \cos(x^2 + e^{x^2})$. Also find $\frac{\partial f}{\partial x}$ using automatic differentiation.	8	L3	CO2
	b.	Assume that the neuron have a sigmoid activation function, perform a forward pass and a backward pass on the network. Assume that the actual output of y is 1 and learning rate is 0.9. Perform another forward pass.	12	L3	CO2

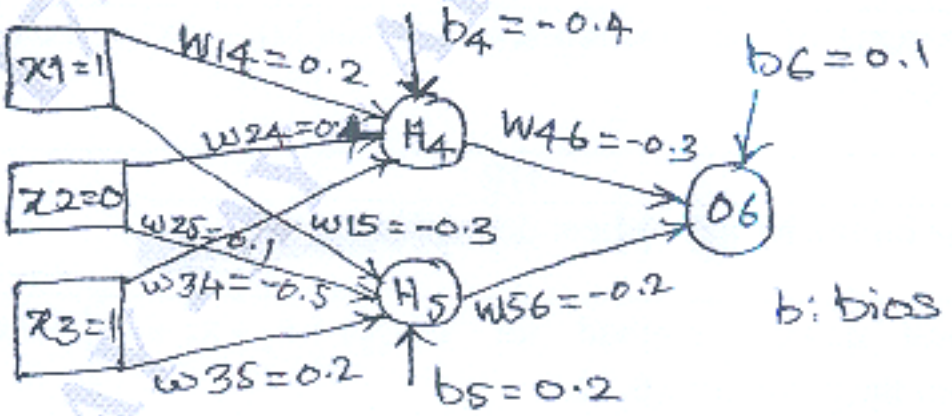
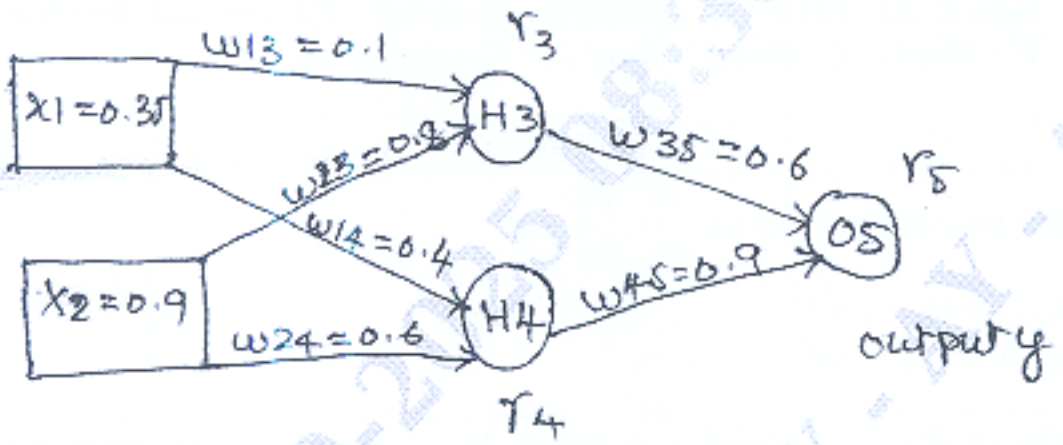


Fig.Q.3(b)

		OR			
Q.4	a.	i) Define the gradient of quadratic cost. ii) Define the gradient of Mean Squared Error (MSE).	8	L2	CO2
	b.	Assume that the neuron have a sigmoid activation function, perform a forward pass and a backward pass on the network. Assume that the actual output of y is 0.5 and learning rate is 1. Perform another forward pass.  Fig.Q.4(b)	12	L3	CO2
		Module – 3			
Q.5	a.	Define convex set. Explain separating hyper plane of convex set.	6	L2	CO3
	b.	Solve the LPP: Minimize $f(x) = 3x_1^2 + 4x_2^2 + 5x_3^2$ subject to the constraint $x_1 + x_2 + x_3 = 10$.	7	L3	CO3
	c.	Write 3-point interval search algorithm and also use it to find maximum : $f(x) = x(5\pi - x)$ on $[0, 20]$ with $\varepsilon = 0.1$.	7	L3	CO3
		OR			
Q.6	a.	Describe local and global optima. List out the four differences between local and global optima.	6	L2	CO3
	b.	Using Hessian matrix classify the relative extrema for the function : $f(x, y) = 1/3x^3 + xy^2 - 8xy + 3$.	7	L3	CO3
	c.	Using Fibonacci search algorithm to minimize $f(x) = x^2$ over $[-5, 15]$ by taking $n = 7$.	7	L3	CO3
		Module – 4			
Q.7	a.	Explain how the gradient descent algorithm works.	6	L2	CO4
	b.	Apply gradient descent method to solve : $f(x) = 3x^2 + 4x - 2$.	7	L3	CO4
	c.	Find the extrema of the function $f(x) = 5 \sin(2x) - 2x^2 - 4x$ using NR method.	7	L3	CO4
		OR			
Q.8	a.	Write a note on stochastic gradient descent algorithm.	6	L2	CO4
	b.	Use steepest descent method for $f(x, y) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from the point $x_1 = (0, 0)$.	7	L3	CO4

	c.	Find the minimum of the function $f(x) = x_1^2 + 2x_1x_2 + 3x_2^2 + 4x_1$ using NR method.	7	L3	CO4
		Module – 5			
Q.9	a.	What is the difference between convex optimization and non-convex optimization?	6	L2	CO5
	b.	Briefly explain the advantages of RMS prop over Adagrad.	7	L3	CO5
	c.	Describe the saddle point problem in machine learning.	7	L2	CO5
		OR			
Q.10	a.	Write a note on stochastic gradient descent with momentum.	6	L2	CO5
	b.	Explain : i) Adagrad optimization strategy ii) Adam	7	L3	CO5
	c.	What is the best optimization algorithm for machine learning?	7	L2	CO5

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