CBCS SCHEME

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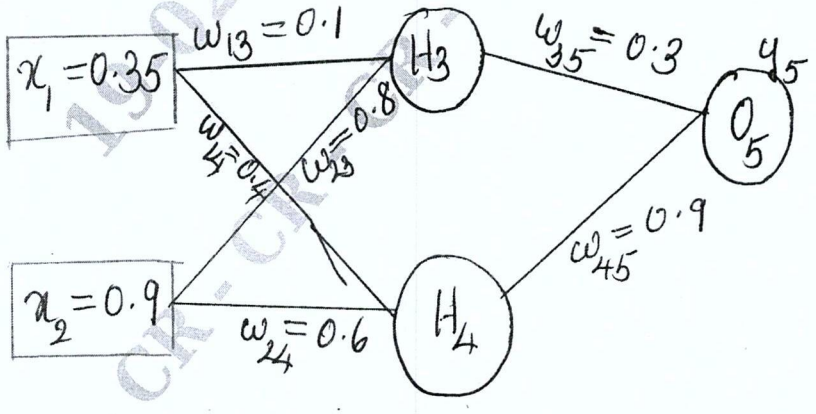
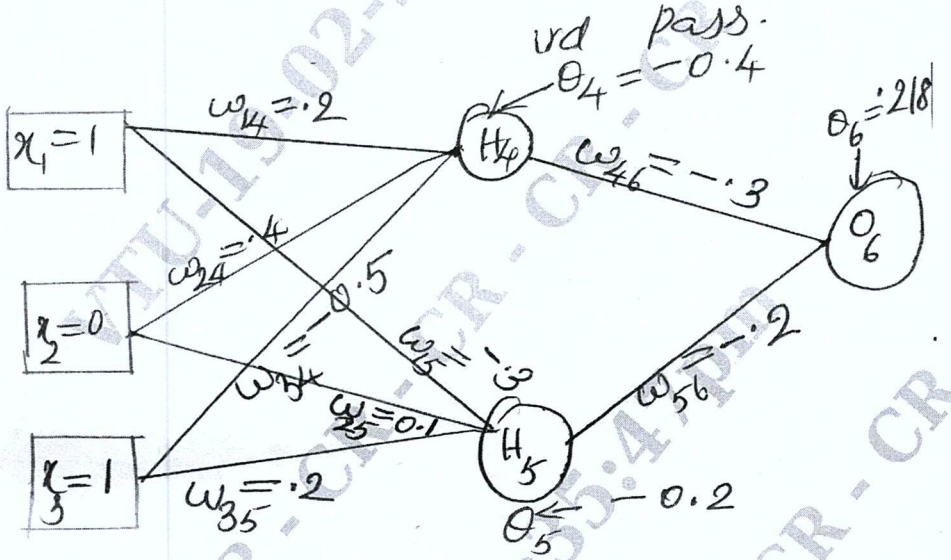
BCS405C

Fourth Semester B.E./B.Tech. Degree Examination, Dec.2025/Jan.2026
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.	Explain the term Jacobian on the content of Data Science, Gradient of a vector with respect to the matrix and Gradient of a matrix with respect to the matrix X, where $X = \begin{bmatrix} x_0 & x_1 \\ x_2 & x_3 \end{bmatrix}$	06	L2	CO1
	b.	Verify whether the functions $u = \frac{x}{y}$, $v = \frac{y}{x}$ are functionally dependent or not.	07	L2	CO1
	c.	Expand $f(x, y) = e^{-(x^2+y^2)}$ about (0,0) as a Taylor series upto the term containing second degree.	07	L2	CO1
		OR			
Q.2	a.	Find the gradient of a matrix Y with respect to the matrix $X = \begin{bmatrix} x_0 & x_1 \\ x_2 & x_3 \end{bmatrix}$ where $Y = \begin{bmatrix} \sin(x_0^2 x_1 x_2) & \cos(x_1 x_2 x_3) \\ x_0^2 + x_1^2 + x_3^2 & x_3^2 + x_2^2 + x_1^2 \end{bmatrix}$	06	L2	CO1
	b.	Find the Jacobian , given $x = u^2 - v^2$. $y = u^2 + v^2$.	07	L2	CO1
	c.	Expand $f(x,y) = e^x \sin y$ about the point $(1, \frac{\pi}{2})$ as a Taylor series upto the term containing third degree.	07	L2	CO1
		Module – 2			
Q.3	a.	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 0.1. Perform another forward pass.  Fig. Q. 3(a)	10	L3	CO2

	b.	The recordings of weekly average price of a stock over 6 consecutive days is given Y shows weekly average price of stock and X shows number of days. Try to fit best possible function f to establish the relationship between number of days and conversion rate using Gradient Descent algorithm. Carryout 2 iterations. x: 1 2 3 4 5 6 y: 10 14 18 22 25 33 The initial a and b are a = 4.9, b = 4.401. The learning rate is mentioned as 0.05. Also plot the prediction and actual data in the graph.	10	L3	CO2
		OR			
Q.4	a.	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.  Fig. Q.4 (a)	10	L3	CO2
	b.	Explain the term mean squared error and its application in Data Science. Also calculate the mean squared error for the data. Actual Value: 10 16 13 19 1 Predicted Value: 7 14 17 20 4 	10	L3	CO2
		Module – 3			
Q.5	a.	Explain the term Global Maxima, Global minima, Local Maxima and Local Minima with the help of graphical representation.	06	L2	CO3
	b.	Analyze the local maxima and local minima of the function, $f(x) = 2x^3 - 3x^2 - 12x + 5$	07	L3	CO3
	c.	Find the nature of the function $f = x^3 + 3xz + 2y - y^2 - 3z^2$ with the help of Hessian Matrix.	07	L2	CO3
		OR			
Q.6	a.	Maximize $f(x) = x(3 - x)^{5/3}$ over (0, 3) using 3 point search method, carry out 5 iterations.	10	L3	CO3
	b.	Minimize $f(x) = x(x - 1.5)$ in [0,1] within the interval of uncertainty 0.25 of the initial interval of uncertainty using Fibonacci Method.	10	L3	CO3

		Module – 4			
Q.7	**a.**	Minimize $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from $x = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$ Using method of Steepest Descent carry out 3 iterations.	**10**	**L3**	**CO4**
	b.	Explain the terms Gradient Descent, Minibatch Gradient Descent and Stochastic Gradient Descent.	**10**	**L2**	**CO4**
		OR			
Q.8	**a.**	Minimize using Newton's method, $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ by taking points as $x = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$	**10**	**L3**	**CO4**
	b.	Explain the advantages of using minibatch gradient descent over gradient descent.	**10**	**L3**	**CO4**
		Module – 5			
Q.9	**a.**	Explain the term moving average. Calculate 5 years moving average for the given data.	**10**	**L3**	**CO5**
	b.	Explain the terms convex optimization and concave optimization.	**10**	**L2**	**CO5**
		OR			
Q.10	**a.**	Explain the optimizers i) RMS prop ii) Adam	**10**	**L2**	**CO5**
	b.	Explain the advantages of Adam optimizer over RMS prop.	**10**	**L2**	**CO5**

Year	1977	1978	1979	1980	1981	1982
Production	14	17	22	28	26	18
Year	1983	1984	1985	1986	1987	1988
Production	29	24	25	29	30	23

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