CBCS SCHEME

USN ☐☐☐☐☐☐☐☐☐☐

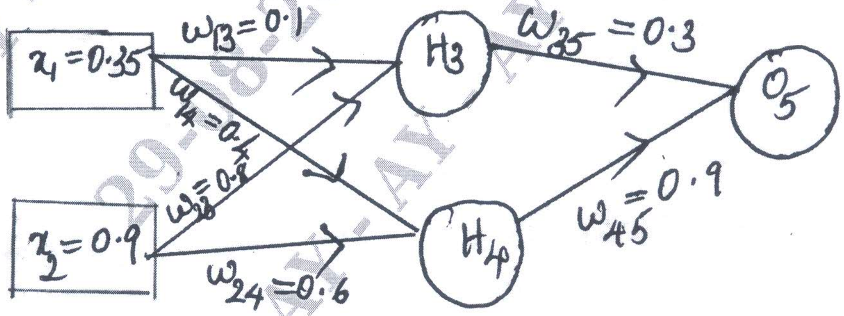
BCS405C

Fourth Semester B.E./B.Tech. Degree Examination, June/July 2024

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 understanding of Jacobian in the context of data science.	**05**	**L2**	**CO1**
	b.	Calculate the gradient of a matrix with respect to the matrix: $X = \begin{bmatrix} x_0 & x_1 \\ x_2 & x_3 \end{bmatrix}$ $Y = \begin{bmatrix} \sin(x_0 + 2x_1) & 2x_1 + x_3 \\ 2x_0 + x_2 & \cos(2x_1 + x_3) \end{bmatrix}$	**07**	**L2**	**CO1**
	c.	Obtain 3rd Degree polynomial for the function $f(x, y) = e^x \sin y$ about the point $\left(1, \frac{\pi}{2}\right)$.	**08**	**L2**	**CO1**
		OR			
Q.2	**a.**	Calculate the gradient, given $u = \frac{yz}{x}$, $v = \frac{xz}{y}$, $w = \frac{xy}{z}$.	**06**	**L2**	**CO1**
	b.	Calculate gradient of a vector with respect to the matrix $X = \begin{bmatrix} x_0 & x_1 \\ x_2 & x_3 \end{bmatrix}$, $Y = x_0 \sin(x_1^2 x_2),\ x_2 \cos(x_3^2 x_0)$	**07**	**L2**	**CO1**
	c.	Calculate the Third Degree polynomial for the function $f(x, y) = xe^y + 1$ near to the point (1, 0).	**07**	**L2**	**CO1**
		Module – 2			
Q.3	**a.**	Explain the term Back propagation.	**06**	**L2**	**CO2**
	b.	Assume that the Neurons 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 the learning rate is 1. Perform another forward pass.  Fig.Q3(b)	**14**	**L3**	**CO2**
		OR			
Q.4	**a.**	Draw a computation graph of function $f(x) = \sqrt{x^2 + e^{x^2}} + \cos(x^2 + e^{x^2})$. Also find $\frac{2f}{2x}$ using Automatic differentiation.	**05**	**L2**	**CO2**

b. Assume that the hidden layer uses sigmoid activation function. Perform a forward pass and a backward pass and predict y. Assume that actual output y = 1 and learning rate is 0.9. 15 L3 CO2

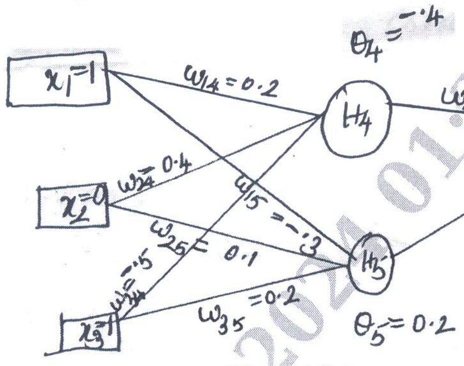


Fig.Q4(b)

Module – 3

Q.5 a. Explain the terms local minima, Global minima and saddle points. Also explain the conditions for a point to be local Extrema with the help of Hessian matrix. 05 L2 CO3

b. Find the local Extrema for the function $f(x,y,z) = x^3 + y^3 + z^3 - 9xy - 9xz + 27x$ 05 L3 CO3

c. By using 3 point interval search method, find maximum of $f(x) = x(3-x)^{5/3}$ over [0, 3]. Carry out 5 iterations. 10 L3 CO3

OR

Q.6 a. Analyze local minima and local Maxima using first derivative method, for the function $f(x) = 2x^3 - 3x^2 - 12x + 5$. 05 L2 CO3

b. Minimize $f(x) = x^2$ over [–5, 15] using Fibonacce method, taking n = 7. 15 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 $X_1 = \begin{bmatrix}0\\0\end{bmatrix}$ using steepest descent method. 12 L3 CO4

b. Explain the terms Gradient Descent, Mini Batch Gradient Descent and Stochastic Gradient Descent. 08 L2 CO4

OR

Q.8 a. Minimize $f(x_1,x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from $X_1 = \begin{bmatrix}0\\0\end{bmatrix}$ using Newton's method. 06 L3 CO4

b. We have recorded weekly average price of a stock over 6 consecutive days. Y shows weekly average price of a stock and X shows number of days. Try to fit best possible function f to establish the relationship between number of days and conversion rates where y = f(x) = a + bx. 14 L3 CO4

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. Perform three iterations. Also plot the prediction and the actual data in the graph.

Module – 5

<table>
<tr><td>Q.9</td><td>a.</td><td>Explain the terms:
(i) Momentum based gradient descent
(ii) RMS prop optimizer</td><td>10</td><td>L2</td><td>CO5</td></tr>
<tr><td></td><td>b.</td><td>Calculate the 5 years of moving average for the given data:
<table>
<tr><td>Year</td><td>1977</td><td>1978</td><td>1979</td><td>1980</td><td>1981</td><td>1982</td></tr>
<tr><td>Production</td><td>14</td><td>17</td><td>22</td><td>28</td><td>26</td><td>18</td></tr>
<tr><td>Years</td><td>1983</td><td>1984</td><td>1985</td><td>1986</td><td>1987</td><td>1988</td></tr>
<tr><td>Production</td><td>29</td><td>24</td><td>25</td><td>29</td><td>30</td><td>23</td></tr>
</table></td><td>10</td><td>L3</td><td>CO5</td></tr>
<tr><td colspan="6">OR</td></tr>
<tr><td>Q.10</td><td>a.</td><td>Explain convex and concave function. Also explain non-convex optimization.</td><td>10</td><td>L2</td><td>CO5</td></tr>
<tr><td></td><td>b.</td><td>Explain the terms :
(i) Adagrad optimizer
(ii) Adam optimizer</td><td>10</td><td>L2</td><td>CO5</td></tr>
</table>

* * * * *