Model Question Paper-I with effect from 2022(CBCS Scheme)

USN

Fourth Semester B.E Degree Examination OPTIMIZATION TECHNIQUES (BCS405C)

TIME:03Hours Max.Marks:100

Note:

- 1. Answer any ${\bf FIVE}$ full questions, choosing at least ${\bf ONE}$ question from each ${\bf MODULE}$
- 2. VTU Formula Hand Book is Permitted
- 3. M: Marks, L: RBT levels, C: Course outcomes.

	Module - 1	M	L	C
Q.1	Let $f(x_1, x_2) = e^{x_1 x_2^2}$ where $x_1 = t \cos t$ and $x_2 = t \sin t$ find $\frac{df}{dt}$.	7	L2	CO1
	b Obtain the gradient of scalar $\phi = 4x_0 + 2x_1 - 3x_2 + x_4$ with respect to	6	L2	CO1
	the matrix $\vec{x} = \begin{bmatrix} x_0 & x_1 \\ x_2 & x_3 \end{bmatrix}$.			
	C Obtain the power series expansion of $f(x, y) = x^2y + 3y - 2$ in terms	7	L3	CO1
	of $(x-1)$ and $(y+2)$ up to second degree.			
	OR			
Q.2	a Discuss the gradient of vectors with respect to matrices.	7	L2	CO1
	b If \vec{x} , $\vec{y} \in \mathbb{R}^2$ and $y_1 = -2x_1 + x_2$, $y_2 = x_1 + x_2$. Show that the Jacobian determinant $ \det \boldsymbol{J} = 3$.	6	L3	CO1
	c Find the second order Taylor's series approximation of the function	7	L3	CO1
	$f(x_1, x_2) = x_1^2 x_2 + 5x_1 e^{x_2}$ about the point $a = 1$, $b = 0$.			
	Module – 2			
Q.3	Draw a computation graph of the function:	8	L3	CO2
Q.5	$f(x) = \sqrt{x^2 + e^{x^2} + \cos(x^2 + e^{x^2})}.$ Also find $\frac{\partial f}{\partial x}$ using automatic			
	differentiation. b Obtain the gradient of quadratic cost.	6	L3	CO2
		U	LJ	COZ
	Find the output at neuron 5, if input vector [0.7, 0.3] using the activation function ReLU.	6	L3	CO2
	w30 = 0.6			
	w31 = 0.1 $w50 = 0.9$			
	$\begin{bmatrix} 1 \\ \end{bmatrix}$ $\begin{bmatrix} 3 \\ \end{bmatrix}$ w53 = 0.3			
	w41 = 0.5			
	2 4 w54 = 0.7			
	w42 = 0.4			
	w40 = 0.8			

Q.4 a last $(x_1, x_2) = \log(x_1) + x_1x_2 - \sin(x_2)$. (i) Draw a computational graph of $f(x_1, x_2)$. (ii) Draw a computational graph of $f(x_1, x_2)$. (ii) Evaluate f at $(x_1, x_2) = (2, 5)$ by forward trace. 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. Module -3 Q.5 a Describe Local and Global optima. Define Hessian matrix. Using the Hessian matrix, classify the relative extreme for the function $f(x_1, y_2) = \frac{1}{3}x^3 + xy^2 - 8xy + 3$ Explain the algorithm of sequential search. Using the sequential search, for an array of size 7 with elements 13, 9, 21, 15, 39, 19, and 27 that starts with 0 and ends with size minus one, 6 locate the position of number 39. OR Q.6 a Minimize $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from $x_1 = x_2 = x_1 + x_2 = x_1 + x_2 = x_1 + x_2 = x_2 = x_1 + x_2 = x_1 + x_2 = x_1 + x_2 = x_1 + x_2 = x_1 + x_2 = x_1 + x_2 = x_1 + x_2 = x_2 = x_1 + x_2 = x_2 = x_1 + x_2 = x_1 + x_2 = x_1 + x_2 = x_2 = x_1 + x_2 = x_2 = x_1 + x_2 = x_1 + x_2 = x_1 + x_2 = x_2 = x_1 + x_2 = x_1 + x_2 = x_1 + x_2 = x_2 = x_1 + x_2$		OR			
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. x1 = 0.35	Q.4 a	Let $f(x_1, x_2) = \log(x_1) + x_1x_2 - \sin(x_2)$. (i) Draw a computational graph of $f(x_1, x_2)$.	8	L3	CO2
	b	forward pass and a backward pass on the network. Assume that the actual	12	L3	CO2
		w14 = 0.4 w35 = 0.6			
		05			
		x2 = 0.9 H4 $y4 = 0.9$ output y			
Q.5 a Describe Local and Global optima. List out the differences between Local and Global optima. b Define Hessian matrix. Using the Hessian matrix, classify the relative extreme for the function $f(x,y) = \frac{1}{3}x^3 + xy^2 - 8xy + 3$			1		
Define Hessian matrix. Using the Hessian matrix, classify the relative extreme for the function $f(x,y) = \frac{1}{3}x^3 + xy^2 - 8xy + 3$ Explain the algorithm of sequential search. Using the sequential search, for an array of size 7 with elements 13, 9, 21, 15, 39, 19, and 27 that starts with 0 and ends with size minus one, 6 locate the position of number 39. OR Q.6 a Minimize $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from the point $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from the point $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from the point $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from the point $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from the point $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from the point $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from the point $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from the point $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from the point $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from the point $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from the point $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from the point $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from the point $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1$	Q.5 a	Describe Local and Global optima.	5	L2	CO3
Explain the algorithm of sequential search. Using the sequential search, for an array of size 7 with elements 13, 9, 21, 15, 39, 19, and 27 that starts with 0 and ends with size minus one, 6 locate the position of number 39. OR Q.6 a Minimize $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from $X_0 = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$ b Write the algorithm for Fibonacci search method. c Using 3-point interval search method, find $X_0 = X_0 = X$	b	Define Hessian matrix. Using the Hessian matrix, classify the relative	7	L3	CO3
with 0 and ends with size minus one, 6 locate the position of number 39. OR OR Q.6 a Minimize $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from 7 L3 C0 b Write the algorithm for Fibonacci search method. c Using 3-point interval search method, find $Max \ f(x) = x(5\pi - x)$ on [0,20] 7 L3 C0 with $\varepsilon = 0.1$ Module -4 Q.7 a Use steepest Descent method for $f(x, y) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ 7 L3 C0 b Explain how the Gradient Descent Algorithm works? c Find the Linear Regression Coefficients using Gradient Descent 7 L2 C0 Method. OR Q.8 a Use the NR method to find the smallest and the second smallest positive 7 roots of the equation $\tan x = 4x$ correct to 4 decimal places. b Write the differences between Stochastic Gradient Descent and Mini 6 L2 C0 Batch Gradient Descent methods.	c	Explain the algorithm of sequential search. Using the sequential search, for	8	L3	CO3
Write the algorithm for Fibonacci search method. C Using 3-point interval search method, find $Max \ f(x) = x(5\pi - x)$ on $\begin{bmatrix} 0,20 \end{bmatrix}$ 7 L3 C0 with $\varepsilon = 0.1$ Module -4 Q.7 a Use steepest Descent method for $f(x, y) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ 7 L3 C0 b Explain how the Gradient Descent Algorithm works? 6 L2 C0 Find the Linear Regression Coefficients using Gradient Descent Find the Linear Regression Coefficients using Gradient Descent Coefficients using Gradient Descent Tools of the equation $tan \ x = 4x \ correct to 4 \ decimal places.$ Write the differences between Stochastic Gradient Descent and Mini Batch Gradient Descent methods.		an array of size 7 with elements 13, 3, 21, 13, 33, 13, and 27 that starts			
Write the algorithm for Fibonacci search method. C Using 3-point interval search method, find $Max \ f(x) = x(5\pi - x)$ on $\begin{bmatrix} 0,20 \end{bmatrix}$ 7 L3 C0 with $\varepsilon = 0.1$ Module – 4 Q.7 a Use steepest Descent method for $f(x, y) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ 7 L3 C0 b Explain how the Gradient Descent Algorithm works? Find the Linear Regression Coefficients using Gradient Descent Find the Linear Regression Coefficients using Gradient Descent Tools of the equation $tan \ x = 4x \ correct to \ 4 \ decimal places$. Write the differences between Stochastic Gradient Descent and Mini Batch Gradient Descent methods.		OR	1	1	1
b Write the algorithm for Fibonacci search method. c Using 3-point interval search method, find $Max \ f(x) = x(5\pi - x)$ on $\begin{bmatrix} 0,20 \end{bmatrix}$ 7 L3 C0 with $\varepsilon = 0.1$ Module – 4 Q.7 a Use steepest Descent method for $f(x, y) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ 7 L3 C0 b Explain how the Gradient Descent Algorithm works? Find the Linear Regression Coefficients using Gradient Descent Method. OR Q.8 a Use the NR method to find the smallest and the second smallest positive roots of the equation tan $x = 4x$ correct to 4 decimal places. b Write the differences between Stochastic Gradient Descent and Mini 6 L2 C0 Batch Gradient Descent methods.	Q.6 a	$X_0 = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$	7	L3	CO3
with $\varepsilon = 0.1$ Module – 4 Q.7 a Use steepest Descent method for $f(x, y) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ 7 L3 C0 b Explain how the Gradient Descent Algorithm works? 6 L2 C0 Find the Linear Regression Coefficients using Gradient Descent Method. 7 L2 C0 OR Q.8 a Use the NR method to find the smallest and the second smallest positive roots of the equation $\tan x = 4x$ correct to 4 decimal places. b Write the differences between Stochastic Gradient Descent and Mini Batch Gradient Descent methods.	b		6	L2	CO3
Q.7 a Use steepest Descent method for $f(x, y) = x_1 - x_2 + 2 x_1^2 + 2x_1 x_2 + x_2^2$ 7 L3 C0 starting from the point $x_1 = (0, 0)$ 6 Explain how the Gradient Descent Algorithm works? 6 L2 C0 Find the Linear Regression Coefficients using Gradient Descent Method. 7 L2 C0	C	Using 3-point interval search method, find $Max\ f(x) = x(5\pi - x)$ on $[0,20]$	7	L3	CO3
Q.7 a Use steepest Descent method for $f(x, y) = x_1 - x_2 + 2 x_1^2 + 2x_1 x_2 + x_2^2$ 7 L3 C0 b Explain how the Gradient Descent Algorithm works? 6 L2 C0 c Find the Linear Regression Coefficients using Gradient Descent Method. 7 L2 C0 OR Q.8 a Use the NR method to find the smallest and the second smallest positive roots of the equation tan $x = 4x$ correct to 4 decimal places. 7 L3 C0 b Write the differences between Stochastic Gradient Descent and Mini 6 L2 C0 Batch Gradient Descent methods.		Module – 4		I	
b Explain how the Gradient Descent Algorithm works? c Find the Linear Regression Coefficients using Gradient Descent Method. 7 L2 CO OR Use the NR method to find the smallest and the second smallest positive roots of the equation tan x = 4x correct to 4 decimal places. b Write the differences between Stochastic Gradient Descent and Mini Batch Gradient Descent methods.	Q.7 a	Use steepest Descent method for $f(x, y) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$	7	L3	CO4
OR Use the NR method to find the smallest and the second smallest positive roots of the equation tan x = 4x correct to 4 decimal places. Write the differences between Stochastic Gradient Descent and Mini 6 L2 CO Batch Gradient Descent methods.	b		6	L2	CO4
Use the NR method to find the smallest and the second smallest positive roots of the equation tan x = 4x correct to 4 decimal places. Description	c		7	L2	CO4
 a roots of the equation tan x = 4x correct to 4 decimal places. b Write the differences between Stochastic Gradient Descent and Mini Batch Gradient Descent methods. 		OR			
b Write the differences between Stochastic Gradient Descent and Mini 6 L2 CO Batch Gradient Descent methods.	Q.8 a		7	L3	CO4
	b	Write the differences between Stochastic Gradient Descent and Mini	6	L2	CO4
	c		7	L2	CO4

Q.9	a	Explain in brief	10	L2	CO5
		1. Adagrad optimization strategy			
		2. RMSprop			
	1.	What is the difference between convex optimization and	5	1.2	CO5
	b	non-convex optimization	3	L2	CO3
	c	Describe the saddle point problem in machine learning	5	L2	CO5
		OR			
Q.10	a	Write a short notes on	10	L2	CO5
		1.Stochastic gradient descent with momentum			
		2.ADAM			
	b	What is the best optimization algorithm for machine learning	5	L2	CO5
	c	Briefly explain the advantages of RMSprop over Adagrad	5	L2	CO5

Model Question Paper-II with effect from 2022(CBCS Scheme)

USN

Fourth Semester B.E Degree Examination OPTIMIZATION TECHNIQUES (BCS405C)

TIME:03Hours Max.Marks:100

Note:

- 1. Answer any ${f FIVE}$ full questions, choosing at least ${f ONE}$ question from each ${f MODULE}$
- 2. VTU Formula Hand Book is Permitted
- 3. M: Marks, L: RBT levels, C: Course outcomes.

	Module - 1	M	L	C
Q.1	a Let $f(x_1, x_2) = x_1^2 + 2x_2$ where $x_1 = \sin t$ and $x_2 = \cos t$ find $\frac{df}{dt}$.	7	L2	CO1
	Obtain the gradient of matrix $\vec{f} = \begin{bmatrix} \sin(x_0 + 2x_1) & 2x_1 + x_3 \\ 2x_0 + x_2 & \cos(2x_2 + x_3) \end{bmatrix}$ with respect to the matrix $\vec{x} = \begin{bmatrix} x_0 & x_1 \\ x_2 & x_3 \end{bmatrix}$.	7	L3	CO1
	Obtain the partial derivatives for (i) $f(x, y) = (x + 2y^3)^2$ (ii) $f(x, y) = x^2y + xy^3$	6	L3	CO1
	OR			
Q.2	a Discuss (i) Gradient of a matrix with respect to a vector. (ii) Gradient of a matrix with respect to a matrix.	10	L2	CO1
	Find the Taylor's series expansion of the function $f(x, y) = x^2 + 2xy + y^3$ at $(x_0, y_0) = (1, 2)$ up to third degree.	10	L3	CO1
	Module – 2			
Q.3	Draw 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 Obtain the gradient of quadratic cost.	6	L3	CO2
	Find the output at neuron 5, if input vector $[0.7, 0.3]$ using the activation function ReLU. $w30 = 0.6$ $w50 = 0.9$ $w41 = 0.5$ $w41 = 0.5$ $w42 = 0.4$ $w40 = 0.8$	6	L3	CO2

	OR			
Q.4 a		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 0.5 and learning rate is 1. Perform another forward pass. $w13 = 0.1$ $y3$ $x1 = 0.35$	12	L3	CO2
	w14 = 0.4 $w23 = 0.8$ $w23 = 0.8$ $w24 = 0.6$ $w35 = 0.6$ $w35 = 0.6$ $w45 = 0.9$ output y			
	Module – 3			
Q.5 a	List out the differences between Local and Global optima.	5	L2	CO3
b	Define Hessian matrix. Using the Hessian matrix, classify the relative extreme for the function $f(x, y) = \frac{1}{3}x^3 + xy^2 - 8xy + 3$	7	L3	CO3
С	Explain the algorithm of sequential search. Using the sequential search, for an array of size 7 with elements 13, 9, 21, 15, 39, 19, and 27 that starts with 0 and ends with size minus one, 6 locate the position of number 39.	8	L2	CO3
	OR			
Q.6 a	Minimize $f(x_1, x_2) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from $X_0 = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$	8	L3	CO3
b	Write the algorithm for Fibonacci search method.	6	L3	CO3
c	Using 3-point interval search method, find $Max\ f(x) = x(5\pi - x)$ on $[0,20]$ with $\varepsilon = 0.1$	6	L2	CO3
	Module – 4			
Q.7 a	Use steepest Descent method for $f(x, y) = x_1 - x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$	7	L2	CO4
b	Explain how the Gradient Descent Algorithm works?	6	L2	CO4
c	Find the Linear Regression Coefficients using Gradient Descent Method.	7	L2	CO4
	OR		_	
Q.8 a	Use the NR method to find the smallest and the second smallest positive	7	L2	CO4
b	777 d 1100 1 d C 1 d C 1 d D	7	L2	CO4
c	Write the Stochastic Gradient Descent Algorithm.	6	L2	CO4
	Module – 5			

Q.9	a	Explain in brief	10	L2	CO5
		1. Adagrad optimization strategy			
		2. RMSprop			
	1.	What is the difference between convex optimization and	5	1.2	CO5
	b	non-convex optimization	3	L2	CO3
	c	Describe the saddle point problem in machine learning	5	L2	CO5
		OR			
Q.10	a	Write a short notes on	10	L2	CO5
		1.Stochastic gradient descent with momentum			
		2.ADAM			
	b	What is the best optimization algorithm for machine learning	5	L2	CO5
	c	Briefly explain the advantages of RMSprop over Adagrad	5	L2	CO5