9. Briefly discuss about any three of the followings :   (3 × 4)= 12
   (i)   Gradient descent algorithm
   (ii) Hebbian learning model
   (iii) Deep learning neural network
   (iv) Self organizing map
   (v) Competitive learning model.

SOFT COMPUTING
(CSEN 5202)

Time Allotted : 3 hrs   **Full Marks : 70**

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.*

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

  (i)   Let A and B are two fuzzy sets with membership function $m_x(A)$, $m_x(B)$. Then $m_x(A \cap B)$ is equal to
         (a) $m_x(A)+m_x(B)$ (c) $m_x(A)-m_x(B)$
         (b) $\max(m_x(A),m_x(B))$ (d) $\min(m_x(A),m_x(B))$.

  (ii)   The size of each chromosome for the problem maximizing a function $f(x) = x^2$ in the interval $0 \le x \le 31$ is
         (a) 8   (b) 5   (c) 4   (d) none of these.

  (iii)   X-OR problem can be solved by
         (a) single layer perceptron   (b) Bayes' theorem
         (c) multi-layer peceptron   (d) all of these.

  (iv)   Learning principle of Kohonen self organizing network is
         (a) supervised   (b) unsupervised
         (c) reinforcement   (d) none of these.

  (v)   Let's assume that a fuzzy set A is defined as follows :
         A = 0·5/50 + 1/60 + 0·5/70 + 0/80 + 1/90 + 0.3/100 ?Which one of the following is A^c :
         (a) 0·5/50 + 1/60 + 0·5/70 + 0/80 + 1/90 + 0.7/100
         (b) 0·5/50 + 0/60 + 0·5/70 + 0/80 + 1/90 + 0.7/100
         (c) 0/50 + 0/60 + 0·5/70 + 1/80 + 0/90 + 0.3/100
         (d) none of the above.

  (vi)   Let A and B are two fuzzy sets and A is not null. Then degree of subset-hood of A in B is defined as
         (a) $|A \cup B| / |A|$ (b) $|A \cup B| / |B|$
         (c) $|A \cap B| / |A|$ (d) $|A \cap B| / |B|$.

(vii)   If crossover between chromosomes in search space does not produce significantly different off-springs, then which of the following statements are true:
I. The crossover operation is not successful.
II. Solution is about to be reached.
III. Parents involved in the crossover operation are similar.
IV. The search space of the problem is not ideal for GAs to operate.
(a) (II), (III) & (IV)   (b) (II) & (III)
(c) (I), (III) & (IV)   (d) all of these.

(viii)   Stochastic gradient descent will guarantee global optima if the error function is
(a) concave   (b) convex
(c) neither (a) nor (b)   (d) both (a) and (b).

(ix)   Let's assume that a fuzzy set A is defined as follows :
A = 0·1/50 + 0·3/60 + 0·5/70 + 0·8/80 + 1/90 + 1/100
What will be the value of | A |?
(a) 3·7   (b) 6
(c) 1·7   (d) none of these.

(x)   Radial basis function can be used to classify
(a) non-linearly separable classes   (b) linearly separable classes
(c) neither (a) nor (b)   (d) both (a) and (b).

Group - B

2.   (a)   What are the differences between crisp and fuzzy set?

(b)   Given two universe of discourse are as follows: **Temp** ={100,200,350,48} and **Pressure** ={25,35,45,12,16}.
moderate_temp and **moderate_press** are two fuzzy sets, where **moderate_temp** ϵ **Temp** and **moderate_press** ϵ **Pressure** are given below:
moderate_temp: {0.9/100F+0.1/200F + 0.25/48F} and
moderate_press: {0.5/35 + 0.3/45 + 0.8/25 + 0.1/16}.
Evaluate membership of the following statement :
"It will be moderate pressure if and only if the temperature is moderate".

3 + 9 = 12

3.   (a)   State the T-norm and S-norm duality postulates.

(b)   Prove De-Morgan's Law using T-norm and S-norm duality.

(c)   Define bounded-product in fuzzy set. Derive bounded sum expression using T-norm and S-norm duality.

2 + 5 + (1 + 4) = 12

Group - C

4.   (a)   Simulate the Boolean function **A "XOR" B** using a multi layered perceptron. Construct the network and show the update of weights of each synaptic connection for at least two iterations.

(b)   Describe Radial basis function network as a classifier.

7 + 5 = 12

5.   (a)   Describe the architecture of Kohonen self-organizing feature maps.

(b)   Consider a Kohonen net with two cluster units and three input units. The weight vectors for the cluster unit are $[0·9, 0·7, 0·6]^T$ and $[0·4, 0·3, 0·5]^T$. Find the winning cluster unit for the input vector $[0·4, 0·2, 0·1]^T$. Find the new weight vector. Consider the learning rate as 0·1.

5 + 7 = 12

Group - D

6.   (a)   Discuss the different types of crossover methods in genetic algorithm.

(b)   Explain the roulette wheel selection algorithm.

(c)   What is the impact of population size in genetic algorithm?

5 + 5 + 2 = 12

7.   (a)   Use genetic algorithm to maximize the function $f(x) = x^2$ for $0 \leq x \leq 31$. The four initial population chromosome's size of five is selected as 01101, 11000, 01000, 10011. Show the detail for first two iterations.

(b)   What are the different types of crossover?

(c)   What happens when — (i) crossover rate is decreased (ii) mutation rate is increased.

6 + 2 + (2 + 2) = 12

Group - E

8.   (a)   Briefly discuss concept of dominance test in the context of multi-objective optimization problem.

(b)   Given a multi-objective optimization problem with two objectives $f_1(x)$ and $f_2(x)$, where $f_1(x)$ is to be maximized and $f_2(x)$ is to minimized, where x is a feasible solution. Determine the non-dominant set of feasible solutions , where each feasible solution along with corresponding objective values, are given in form of a triplet i.e., **[x, f₁(x),f₂(x)]** as followings:- (1,4,3); (2,2,5); (3,6,2);(4,5,4);(5,8,3)

3 + 9 = 12