

**SOFT COMPUTING FUNDAMENTALS  
(CSBS 4121)**

**Time Allotted : 2½ hrs**

**Full Marks : 60**

*Figures out of the right margin indicate full marks.*

*Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.*

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

**Group – A**

1. Answer any twelve:

**12 × 1 = 12**

*Choose the correct alternative for the following*

- (i) What is the primary aim of soft computing?
  - (a) Eliminate uncertainty in data
  - (b) Achieve precise analytical models
  - (c) Tolerate imprecision and uncertainty
  - (d) Replace all hard computing models
- (ii) In GA, a potential solution to a problem is called a:
  - (a) Node
  - (b) Gene
  - (c) Chromosome
  - (d) Operator
- (iii) The genetic operator that simulates natural reproduction is:
  - (a) Mutation
  - (b) Crossover
  - (c) Selection
  - (d) Evaluation
- (iv) Which component of a biological neuron receives input from other neurons?
  - (a) Axon
  - (b) Soma
  - (c) Dendrites
  - (d) Synapse
- (v) What is the mathematical operation performed in an artificial neuron before applying the activation function?
  - (a) Multiplication only
  - (b) Summation of weighted inputs
  - (c) Division of inputs
  - (d) Integration
- (vi) Multilayer Perceptron (MLP) is capable of solving problems that are:
  - (a) Linearly separable only
  - (b) Non-linearly separable
  - (c) Only for classification
  - (d) Logical AND problems only
- (vii) The membership value in a fuzzy set lies between:
  - (a) -1 and 1
  - (b) 0 and  $\infty$
  - (c) 0 and 1
  - (d)  $-\infty$  and  $\infty$

- (viii) In fuzzy logic, implication refers to:
  - (a) Logical AND
  - (b) Transformation of fuzzy sets
  - (c) A fuzzy relation that expresses "IF-THEN" rules
  - (d) Conversion to Boolean form
- (ix) A decision matrix helps in:
  - (a) Applying fuzzy membership functions
  - (b) Handling inconsistent rules
  - (c) Structuring multi-attribute decisions
  - (d) Encoding chromosomes
- (x) What does "Pareto dominance" mean?
  - (a) One solution is worse in all objectives
  - (b) One solution is equal to another in all objectives
  - (c) One solution is better in at least one objective and not worse in others
  - (d) All solutions are incomparable

*Fill in the blanks with the correct word*

- (xi) Pheromone quantity in ACO is \_\_\_\_\_ proportional to path selection.
- (xii) The formula for sigmoid activation function is\_\_\_\_\_.
- (xiii) \_\_\_\_\_ layer in MLP is responsible for learning complex features.
- (xiv) Neuron can send \_\_\_\_\_ signal at a time.
- (xv) \_\_\_\_\_ activation function outputs values strictly between 0 and 1.

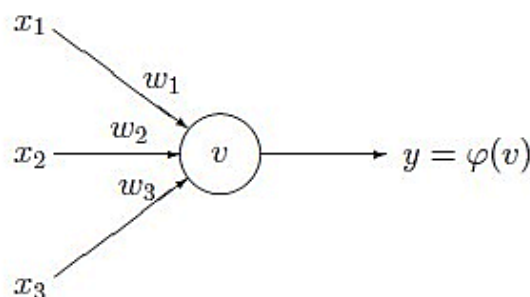
### Group - B

2. (a) Briefly Suppose a genetic algorithm uses chromosomes of the form  $x = abcdefgh$  with a fixed length of eight genes. Each gene can be any digit between 0 and 9. Let the fitness of individual  $x$  be calculated as:  $f(x) = (a+b) - (c+d) + (e+f) - (g+h)$ , Let the initial population consist of four individuals with the following chromosomes:  $x_1 = 65413532$  ;  $x_2 = 87126601$ ;  $x_3 = 23921285$  ;  $x_4 = 41852094$ .
    - (i) Cross the fittest two individuals using one–point crossover at the middle point
    - (ii) Cross the second and third fittest individuals using a two–point crossover (points b and f)
    - (iii) Cross the first and third fittest individuals (ranked 1st and 3rd) using a uniform crossover. [[CO2](Apply/IOCQ)]
  - (b) Suppose the new population consists of the six offspring individuals received by the crossover operations in the above question. Evaluate the fitness of the new population, showing all your workings. Has the overall fitness improved? [[CO2](Analyse/IOCQ)]
  - (c) Discuss the applications of Soft Computing? [[CO1](Remember/LOCQ)]
- (2 + 2 + 3) + 3 + 2 = 12**
3. (a) List and briefly describe the main tools and techniques used in soft computing. [[CO1](Remember/LOCQ)]

- (b) Describe mutation in genetic algorithms and explain why it is necessary? [[CO2](Remember/LOCQ)]
  - (c) Briefly discuss Roulette Wheel Selection Algorithm. [[CO1)(CO2)(Understand/LOCQ)]
- 6 + 3 + 3 = 12**

### Group - C

- 4. (a) Draw a labelled diagram of an artificial neuron and explain its components? [[CO3)(Remember/LOCQ)]
  - (b) Explain the concept of linear separability with the help of an example. Explain how AND and OR logic gates are realised using SLP. [[CO3)(Apply/IOCQ)]
  - (c) What is an epoch? [[CO3)(Remember/LOCQ)]
- 3 + (1 + 3 + 3) + 2 = 12**
- 5. (a) Below is a diagram of a single artificial neuron (unit):



The node has three inputs  $x = (x_1, x_2, x_3)$  that receive only binary signals (either 0 or 1). How many different input patterns this node can receive? What if the node had four inputs? Give a formula that computes the number of binary input patterns for a given number of inputs? [[CO3)(Apply/IOCQ)]

- (b) Explain how XOR gate is implemented using MLP? Draw the diagram clearly indicating the weights and bias. [[CO3)(Apply/IOCQ)]
- (2 + 2 + 2) + 6 = 12**

### Group - D

- 6. (a) Explain the concept of Fuzzy Logic in brief with example. [[CO4)(Understand /LOCQ)]
- (b) Compare and contrast between crisp set and fuzzy set. [[CO4)(Understand/LOCQ)]
- (c) Suppose R and S be two sets where:

R=

	$Y_1$	$Y_2$
$X_1$	0.5	0.4
$X_2$	0.7	0.3

S=

	$Z_1$	$Z_2$	$Z_3$
$Y_1$	0.6	0.2	0.4
$Y_2$	0.3	0.1	0.5

Calculate  $T=RoS$  using Fuzzy Max-Min Composition. [[CO4)(Apply/IOCQ)]

**3 + 3 + 6 = 12**

7. (a) Explain Fuzzy Implication Operators using the following definitions: (i) Classical (Zadeh), (ii) Mamdani and (iii) Lukasiewicz. [[CO4](Understand/LOCQ)]
- (b) Explain Trapezoidal Fuzzy membership Function with example. [[CO4](Understand/LOCQ)]
- (c) Determine the relation between two given fuzzy sets by using Boolean implication operation:  $A = \{(0.2,1) (0.5,2) (0.8,3) (1,4)\}$  and  $B = \{(1,1) (0.6,2) (0.2,3)\}$ . [[CO4](Apply/IOCQ)]
- 6 + 3 + 3 = 12**

### Group - E

8. (a) What do you mean by dominated set? [[CO5](Remember/LOCQ)]
- (b) Describe Ant colony optimization algorithms in brief. [[CO6](Remember/LOCQ)]
- (c) What do you mean by multi-objective optimization? Explain with an example. [[CO2](Remember/LOCQ)]
- 3 + 6 + 3 = 12**
9. (a) Describe the basic working steps of a MOGA. [[CO6](Understand/LOCQ)]
- (b) What is a Pareto Optimal Front? [[CO5](Remember/LOCQ)]
- (c) How can Rough Sets be used in feature selection? Provide a brief explanation. [[CO5](Analyse/IOCQ)]
- 6 + 2 + 4 = 12**

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	56.25	43.75	0