

**SOFT COMPUTING
(AEIE 4132)**

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) _____ represents the fuzzy logic.
(a) IF-THEN rules (b) IF-THEN-ELSE rules
(c) Both (a) & (b) (d) None of the above
- (ii) Which of the following is associated with fuzzy logic?
(a) Crisp set logic (b) Many-valued logic
(c) Two-valued logic (d) Binary set logic.
- (iii) In the fuzzy controller, if both the input variables error and change of error have 7 linguistic terms, then the possible number of fuzzy rules will be
(a) 14 (b) 49 (c) 77 (d) 21.
- (iv) In a fuzzy controller, if the error is negative and the change of error is negative, the control output should be
(a) positive (b) negative (c) zero (d) in can be any value.
- (v) A perceptron can be defined as _____.
(a) a double-layer auto-associative neural network
(b) a neural network with feedback
(c) an auto-associative neural network
(d) a single-layer feed-forward neural network with pre-processing
- (vi) The number of hidden layers that can be present between the input and output layers in BPNN is
(a) 2 (b) any numbers (c) 5 (d) 1.
- (vii) Which is true for neural networks?
(a) It has a set of nodes and connections
(b) Each node computes its weighted input
(c) Node could be in an excited state or non-excited state
(d) All of the mentioned.

- (viii) Genetic algorithms are example of
 (a) Heuristic (b) Evolutionary algorithm
 (c) Particle swarm optimization (d) Ant colony optimization.
- (ix) A 3-input neuron is trained to output a 0 when the input is 110 and a 1 when the input is 111. After generalization, the output will be 0, when and only when the input is
 (a) 000 or 110 or 011 or 101 (b) 000 or 010 or 110 or 100
 (c) 100 or 111 or 101 or 001 (d) 010 or 100 or 110 or 101
- (x) Which of the following(s) is/are found in Genetic Algorithms?
 (i) Crossover (ii) Selection (iii) Reproduction (iv) Mutation
 (a) i & ii only (b) i, ii & iii only
 (c) ii, iii & iv only (d) all of the above

Fill in the blanks with the correct word

- (xi) In ANN, Neurons interconnected among multiple network layers are referred to as _____.
- (xii) The complexity of ANN is dependent upon _____.
- (xiii) Chromosomes are basically the strings of _____.
- (xiv) The error correction learning law is associated with _____.
- (xv) If $\mu_B(x) = \{(x_1, 0.1), (x_2, 0.4), (x_3, 0.3)\}$; $\mu_{A^3}(x_1)$ is _____.

Group - B

2. (a) Demonstrate triangular type membership function with appropriate diagram and show the mathematical formulation. [[CO2](Understand/LOCQ)]
- (b) Graphically represent the following membership functions and express mathematical relations for them:
 (i) the notion of being baby; $\mu_{\text{baby}}(\text{age})$
 (ii) the notion of feeling cold; $\mu_{\text{cold}}(\text{temp})$
 (iii) the notion of being old; $\mu_{\text{old}}(\text{age})$ [[CO3](Apply/IOCQ)]
- 3 + (3 × 3) = 12**
3. (a) What is soft computing? Write the main goal of sot-computing. [[CO1](Understand/LOCQ)]
- (b) List 4 merits and 2 demerits of Fuzzy logic. [[CO1](Remember/LOCQ)]
- (c) Estimate the membership function for children aged 5 to 12 years. Consider the average life span of human beings is 100 years. [[CO2](Apply/IOCQ)]
- (d) How are pie MFs different from triangular MFs? Explain logically. [[CO1](Understand/LOCQ)]
- (1 + 1) + 3 + 3 + 4 = 12**

Group - C

4. (a) When should you use fuzzy controllers in place of conventional controllers? [[CO3](Understand/LOCQ)]

- (b) What is normalization and denormalization in fuzzy controller design? [[CO3](Remember/LOCQ)]
- (c) Evaluate the mathematical expression of the fuzzy PD controller. Apply the equation of the fuzzy PD controller to derive the expression of the fuzzy PI controller. [[CO3](Evaluate/HOCQ)]
- (d) Explain the Centre of Area defuzzification procedure. [[CO3](Understand/LOCQ)]
2 + 3 + (2 + 3) + 2 = 12
5. (a) Explain the importance of the scaling factor in fuzzy controller design. [[CO3](Understand/LOCQ)]
- (b) Develop a 5x5 rule matrix for two input variables error and change of error (e and Δe) defined on the span of $[-1, +1]$. Take the linguistic terms as {NB, NS, Z, PS, PB}. [[CO3](Understand/LOCQ)]
- (c) In fuzzy controller design, after fuzzification, the following values are obtained for error (e) and change of error (Δe).
- $$for(e) = 0.7 \Rightarrow \begin{cases} \mu_{PB}(e) = 0.3 \\ \mu_{PS}(e) = 0.6 \end{cases}; for(\Delta e) = -0.9 \Rightarrow \begin{cases} \mu_{NB}(\Delta e) = 0.8 \\ \mu_{NS}(\Delta e) = 0.2 \end{cases}$$
- Determine the following from the above statement:
- (i) How many fuzzy if-then rules can be generated?
- (ii) Write the if-then rules.
- (iii) Apply Mamdani implication to find the numerical values from the rules. [[CO3](Apply/IOCQ)]
2 + 3 + (1 + 4 + 2) = 12

Group - D

6. (a) Outline differences between BPNN and RBFN by drawing their architecture. [[CO5](Understand/LOCQ)]
- (b) Demonstrate the steps of back propagation neural network (BPNN) to notice the weight change in the network in the presence of error. [[CO5](Analyse/IOCQ)]
- (c) Inspect the importance of learning rate in backpropagation neural networks. [[CO5](Understand/LOCQ)]
(2 + 2) + 6 + 2 = 12
7. (a) How is an artificial neural network (ANN) related to the biological neural network (BNN)? [[CO4](Understand/LOCQ)]
- (b) Realize 'AND' and 'XOR' gate truth tables using the McCulloch-Pitts neuron model. [[CO4](Apply/IOCQ)]
- (c) What is the necessity of clustering of data? [[CO5](Understand/LOCQ)]
- (d) What is the utility of activation function in neural networks? Give any two examples of activation functions used in neural network modeling. [[CO4](Understand/LOCQ)]
3 + 4 + 2 + (1 + 2) = 12

Group - E

8. (a) Mention two advantages and limitations of the genetic algorithm. [[CO6](Remember/LOCQ)]

- (b) Explain the term global optimum in genetic algorithm application. [[CO6](Understand/LOCQ)]
- (c) Plan the different steps to design a neuro-fuzzy hybrid system with a block diagram. [[CO6](Analyse/IOCQ)]
4 + 2 + 6 = 12
9. (a) Suppose a genetic algorithm uses chromosomes of the form $x = a b c d e f g h$ 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: $f(x) = (a + b) - (c + d) + (e + f) - (g + h)$, and let the initial population consist of four individuals with the following chromosomes:
 $x_1 = 6 5 4 1 3 5 3 2$
 $x_2 = 8 7 1 2 6 6 0 1$
 $x_3 = 2 3 9 2 1 2 8 5$
 $x_4 = 4 1 8 5 2 0 9 4$
 Evaluate the fitness of each individual, showing all your workings, and arranging them in order with the fittest first and the least fit last. [[CO6](Analyse/HOCQ)]
- (b) Analyze the following crossover operations:
 (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. [[CO6](Analyse/IOCQ)]
- (c) Suppose the new population consists of the six offspring individuals, received from the crossover operations of the above question. Derive the fitness of the new population, showing all your workings. Has the overall fitness improved? [[CO6](Analyse/IOCQ)]
- (d) By looking at the fitness function and considering that genes can only be digits between 0 and 9 choose the chromosome representing the optimal solution (i.e. with the maximum fitness). Determine the value of the maximum fitness. [[CO6](Understand/LOCQ)]
- (e) By looking at the initial population of the algorithm, examine whether it will be able to reach the optimal solution without the mutation operator. [[CO6](Understand/LOCQ)]
2 + 3 + 3 + 3 + 1 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	50	42.70	7.30