# Gandhi Institute of Engineering and Technology University, Odisha, Gunupur
## (GIET University)

B. Tech (Fifth Semester - Regular) Examinations, November 2025

## 23BCMPE35011– Genetic Algorithm & It's Application

(CSE-AIML)

Time: 3 hrs Maximum: 70 Marks

**Answer ALL questions**

**(The figures in the right hand margin indicate marks)**

**PART – A** **(2 x 5 = 10 Marks)**

| | | CO # | Blooms Level |
|---|---|---|---|
| Q.1. | Answer ***ALL*** questions | | |
| a. | Define soft computing. State two characteristics that distinguish it from hard computing. | CO1 | K1 |
| b. | What is a membership function in fuzzy logic? Give the mathematical representation of a triangular membership function. | CO2 | K2 |
| c. | List the three main operators in genetic algorithms and their purpose. | CO3 | K1 |
| d. | Define fitness function and explain its role in genetic algorithms. | CO3 | K2 |
| e. | Name two real-world applications where genetic algorithms are successfully implemented. | CO5 | K1 |

**PART – B** **(10 x 5 = 50 Marks)**

| | | Marks | CO # | Blooms Level |
|---|---|---|---|---|
| | Answer ***ALL*** the questions | | | |
| 2. a. | Explain the concept of fuzzy set operations (union, intersection, complement) with mathematical formulations.<br>Numerical Problem: Given fuzzy sets:<br>• A = {($x_1$, 0.4), ($x_2$, 0.8), ($x_3$, 0.2)}<br>• B = {($x_1$, 0.7), ($x_2$, 0.3), ($x_3$, 0.9)}<br>Calculate:<br>i. A ∪ B using max operation<br>ii. A ∩ B using min operation<br>iii. Complement of A ($\bar{A}$)<br>iv. (A ∪ B) ∩ $\bar{A}$ | 10 | CO2 | K1 |
| | (OR) | | | |
| b. | Describe the Mamdani fuzzy inference system with complete block diagram. Explain each component in detail.<br>Practical Example: Design a simple fuzzy system for air conditioner control with:<br>• Input: Room Temperature (Cold, Moderate, Hot)<br>• Output: AC Speed (Low, Medium, High)<br>• Write 3 fuzzy rules and explain the inference process | 10 | CO2 | K2 |
| 3.a. | Explain triangular and trapezoidal membership functions with their mathematical representations and graphical illustrations.<br><br>Numerical Problem: For a temperature control system with triangular membership functions:<br>Cold: (5, 15, 25)<br>Warm: (20, 30, 40)<br>Hot: (35, 45, 50) | 10 | CO3 | K3 |

For input temperature = 28°C, calculate:
i. Membership values for each linguistic variable
ii. Which category has the highest membership?
iii. Apply defuzzification using Centroid method if output functions are: Low(0,25,50), Medium(25,50,75), High(50,75,100)

(OR)

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|---|---|---|---|---|
| b. | Compare and contrast the following defuzzification methods with mathematical formulations:<br>i. Centroid method<br>ii. Bisector of Area method<br>iii. Mean of Maximum method<br>iv. Smallest of Maximum method<br>Provide a numerical example demonstrating the Centroid method for a simple fuzzy output. | 10 | CO3 | K3 |
| 4.a. | Explain the working principle of Roulette Wheel Selection in genetic algorithms. Discuss its advantages and limitations.<br>Numerical Problem: A population of 5 chromosomes has fitness values: 12, 18, 25, 30, 15.<br>Calculate:<br>i. Total fitness of population<br>ii. Selection probability for each chromosome<br>iii. Cumulative probability<br>iv. Which chromosomes would be selected using random numbers: 0.3, 0.7, 0.9? | 10 | CO4 | K3 |

(OR)

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| b. | Compare Tournament Selection, Rank Selection, and Roulette Wheel Selection methods in genetic algorithms. Discuss when each method is most suitable.<br>Implementation: Design a Tournament Selection algorithm with tournament size = 3 for a population with fitness values [5, 12, 8, 20, 15]. Show one tournament execution. | 10 | CO4 | K3 |
| 5.a. | Explain crossover operations in genetic algorithms. Describe single-point, two-point, and uniform crossover with examples.<br>Numerical Problem: Given parent chromosomes:<br>• Parent 1: 11010110<br>• Parent 2: 00111001<br>Perform:<br>i. Single-point crossover at position 4<br>ii. Two-point crossover at positions 2 and 6<br>iii. Uniform crossover with mask: 10110010<br>iv. Calculate Hamming distance between original parents and each offspring set | 10 | CO5 | K3 |

(OR)

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|---|---|---|---|---|
| b. | Design a Genetic-Fuzzy hybrid model for autonomous vehicle speed control where GA optimizes fuzzy membership function parameters.<br>System Design:<br>Components:<br>1. Fuzzy Controller Inputs:<br>• Distance to obstacle (0-100m) | 10 | CO5 | K3 |

- Current speed (0-100 km/h)

2. Fuzzy Controller Output:
    - Acceleration/Deceleration (-5 to 5 m/s²)
3. GA Optimization:
    - Optimize membership function parameters (α, β, γ)
    - Fitness: Safety + Comfort + Efficiency
    - Population size: 30, Generations: 50

Tasks:

i. Design initial membership functions with GA-tunable parameters

ii. Define 6 fuzzy rules

iii. Create fitness function combining three objectives with weights

iv. Show one generation of GA evolution (initialization, selection, crossover, mutation)

v. Demonstrate final optimized fuzzy system performance

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|---|---|---|---|---|
| 6.a. | Discuss DEAP (Distributed Evolutionary Algorithms in Python) and PyGAD libraries. Compare their features, advantages, and use cases. Explain the workflow of GA implementation using these tools. | 10 | CO6 | K2 |
| | (OR) | | | |
| b. | Explain Genetic-Fuzzy hybrid systems. Discuss how GAs can be used to optimize fuzzy system parameters.<br>Case Study: Design a GA-Fuzzy system for medical diagnosis with:<br>i. GA optimization of membership function parameters<br>ii. Fuzzy rule optimization using GA<br>iii. Integration methodology<br>iv. Advantages over traditional approaches | 10 | CO6 | K2 |

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