JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -3 EXAMINATION- 2024

B.Tech-VIII Semester (CSE/IT/ECE/CE)

COURSE CODE (CREDITS):21B1WMA831 (3) MAX. MARKS: 35

COURSE NAME: Soft Computing & Optimization Algorithms

COURSE INSTRUCTORS: Dr. B. K. Pathak MAX. TIME: 2 Hours

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***Note:*** *(a) All questions are compulsory.*

*(b)Marks are indicated against each question in square brackets.*

*(c) The candidate is allowed to make Suitable numeric assumptions wherever required for solving problems*

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1. Let $X = \{1, 2, 3, 4, 5\}$ and fuzzy set $A = \{(1, 0.7), (2, 0.3), (3, 0.5), (4, 0.9), (5, 0.6)\}$, Find the $\alpha$ cut set for $\alpha = 0.3,\ 0.5$ and $0.9$. Also find the level set of $A$.

   **[CO-2][6 Marks]**

2. The fuzzy set $A$ representing the "satisfaction level" of customers in a restaurant, whose membership function $\mu_A(x)$ is given as: **[CO-2] [6 Marks]**

$$\mu_A(x) = \begin{cases} \dfrac{(x-20)}{20} & ;\ 20 < x < 40 \\ 1 & ;\ 40 \le x \le 60 \\ \dfrac{(80-x)}{20} & ;\ 60 < x < 80 \\ 0 & ;\ otherwise \end{cases}$$

   where $x$ is the customer satisfaction score on a scale from 0 to 100,

   (a) Find the membership value of $\{10, 30, 50, 70, 90\}$.

   (b) Plot the membership function of fuzzy set $A$.

   (c) Also, find the cardinality of fuzzy set $A$.

3. Let's create a fuzzy logic system for an examination grading system using a Gaussian membership function to define grades based on scores. In this system, fuzzy sets for grades are define as: "Excellent", "Good", and "Fair". **[CO-3] [6 Marks]**

   (a) Define a Gaussian membership function with the parameters for "Excellent" Grade with a mean $(\mu) = 90$, and standard deviation $(\sigma)$: 5.

(b) Define a Gaussian membership function with the parameters for "Good" Grade with a mean $(\mu) = 75$, and a standard deviation $(\sigma)$: 5.

(c) Define a Gaussian membership function with the parameters for "Fair" Grade with a mean $(\mu) = 60$, and a standard deviation $(\sigma)$: 5.

(d) Find the membership values for scores {45, 65, 85, 95} for each grade.

4. 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) and let the initial population consist of four individuals with the following chromosomes: **[CO-4] [6]**

$x_1 = 6\ 5\ 4\ 1\ 3\ 5\ 3\ 2$
$x_2 = 8\ 7\ 1\ 2\ 6\ 6\ 0\ 1$
$x_3 = 2\ 3\ 9\ 2\ 1\ 2\ 8\ 5$
$x_4 = 4\ 1\ 8\ 5\ 2\ 0\ 9\ 4$

(a) Evaluate the fitness of each individual, showing all your workings, and arrange them in order with the fittest first and the least fit last.

(b) Perform the crossover between two individuals ($x_2$ & $x_3$) using one–point crossover at the middle point and calculate their fitness.

5. A roulette wheel for genetic algorithm has the following values assigned to different sections: **[CO-4] [7]**

i. Section $A_1$: 25% probability of being selected
ii. Section $A_2$: 15% probability of being selected
iii. Section $A_3$: 20% probability of being selected
iv. Section $A_4$: 40% probability of being selected

If we need to select 10 parents for reproduction using this roulette wheel.

(a) What is the probability of selecting section $A_1$ exactly once in 10 spins of the roulette wheel?

(b) What is the probability of selecting section $A_2$ at least twice in 10 spins of the roulette wheel?

(c) What is the expected number of times section $A_3$ will be selected in 10 spins of the roulette wheel?

(d) If we spin the roulette wheel 10 times, how many parents will be selected from Section $A_4$?

6. Write the four important characteristics of soft computing. **[CO-1] [4]**