# Nirma University
## Institute of Technology
### M. Tech CSE (Data Science) Sem. II
### 6CS268ME25 – Soft Computing
### Sessional Examination, Feb 2026

Total Marks: 50                                   Time: 120 minutes

Roll No. | 25MCD005 | | Supervisor's initial with date | TKB 24|2

Instructions:
1. Attempt all questions.
2. Figures to the right indicate full marks.
3. Draw neat sketches wherever necessary.
4. Assume suitable data wherever necessary and specify clearly.

**Q 1**
(CO 1)
(BL 1)
What is hard computing? What is soft computing? Critically compare hard computing and soft computing. **[10]**

**Q 2**
(CO 1)
(BL 1)
What is swarm intelligence, and computational swarm intelligence? Give examples of biological swarm systems. Define an example problem and discuss how it can be solved using swarm/collective intelligence. **[10]**

**Q 3**
(CO 2)
(BL 3)
Assume that we want to maximize the function $f(x)=-(x^2) + 8x + 2$ using a Genetic Algorithm (GA). Each chromosome is encoded as a 4-bit binary string representing integer values $x \in [0,15]$. The population size is 4. The initial population (Generation 0) is: C1 = 0010 (x = 2), C2 = 0100 (x = 4), C3 = 0110 (x = 6), C4 = 1000 (x = 8). The selection method is Roulette Wheel Selection. The crossover probability is 1 (crossover always occurs), mutation probability is 0 (no mutation), and elitism is not used. To make the algorithm completely deterministic, use the following predefined random numbers for roulette wheel selection: $r_1 = 0.10$, $r_2 = 0.30$, $r_3 = 0.70$, $r_4 = 0.95$. For crossover point selection, use single-point crossover with the following fixed crossover points: for Parent Pair 1, crossover occurs after bit 2; for Parent Pair 2, crossover occurs after bit 3. (a) Compute the fitness value for each chromosome in the initial population. (b) Compute the total fitness of the population. (c) Determine the selection probability and cumulative probability for each chromosome. (d) Using the given roulette wheel random numbers, identify the selected parents. (e) Perform single-point crossover using the specified deterministic crossover points. (f) Write the new population after one generation. (g) Compute the fitness of the new population. (h) Determine whether the population is moving toward the global maximum and state the theoretical maximum value of the function. **[20]**

**Q 4**
(CO 1)
(BL 2)
Explain and compare: (a) Reflexive Relation, Anti-Reflexive Relation, Symmetric Relation, Anti-Symmetric Relation, Transitive Relation, Equivalence Relation (b) Subnormal Fuzzy Set, Height of a Fuzzy Set **[10]**