PROBLEM 1:

Consider the problem of maximising the following function.

$$f(\mathbf{x}) = -\sum_{i=1}^{m}\left(\sum_{j=1}^{4}(x_j - C_{ji})^2 + \beta_i\right)^{-1}, \text{ where}$$

$$m = 10$$

$$\beta = \frac{1}{10}(1, 2, 2, 4, 4, 6, 3, 7, 5, 5)^T$$

$$\mathbf{C} = \begin{pmatrix} 4.0 & 1.0 & 8.0 & 6.0 & 3.0 & 2.0 & 5.0 & 8.0 & 6.0 & 7.0 \\ 4.0 & 1.0 & 8.0 & 6.0 & 7.0 & 9.0 & 3.0 & 1.0 & 2.0 & 3.6 \\ 4.0 & 1.0 & 8.0 & 6.0 & 3.0 & 2.0 & 5.0 & 8.0 & 6.0 & 7.0 \\ 4.0 & 1.0 & 8.0 & 6.0 & 7.0 & 9.0 & 3.0 & 1.0 & 2.0 & 3.6 \end{pmatrix}$$

Develop a Genetic Algorithm-based solution to solve the above-stated problem. Following guidelines should be used to develop the solution.

- The function is usually evaluated on the hypercube $x_j \in [0,10] \forall\, j = 1,2,3,4$
- Binary encoding approach should be used to design the chromosome.
- The population size is 20, and it is fixed.
- Initial population should be constructed randomly.
- Proper parent selection mechanism should be incorporated.
- A single-point crossover operator should be used. The probability of the crossover operator is 0.5.
- Bit flip operation should be used in the mutation operator. The probability of the mutation operator is 0.1.
- An appropriate metric should be used to assess the population's quality.
- Demonstrate the approach's effectiveness by showing the population up to a minimum 500 generations.

PROBLEM 2:

2. Given an undirected weighted graph $G=(V,E,W)$, a minimum spanning tree (MST) or minimum weight spanning tree is a subset of the edges of G that connects all the vertices together, without any cycles and with the minimum possible total edge weight. Assume G is connected and any edge weight $w_j \geq 0, w_j \in W$.
   Develop a Genetic Algorithm-based solution to solve the above-stated problem. Following guidelines should be used to develop the solution.
   - Let G is a complete graph where $|V|=30$. You may assign the edge weight randomly within the range of 0 to 1.
   - Use an appropriate chromosome encoding approach.

- The population size is 50, and it is fixed.
- Initial population should be constructed randomly.
- Proper parent selection mechanism should be incorporated.
- A multi-point crossover operator should be used. The probability of the crossover operator is 0.8 and it will be gradually reduced to 0.1
- Use an appropriate mutation operator, and the probability of the mutation operator is 0.05.
- An appropriate metric should be used to assess the population's quality.
- Demonstrate the approach's effectiveness by showing the population up to a minimum 500 generations.