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JK Lakshmipat University Jaipur

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Theory Examination, May 2026

B. Tech. (CSE), Semester IV

Roll No.....

AS1113: Optimization for Computer Science

Time: 3 hours

Max. Marks: 40

Instructions to students:

1. Do not write anything other than your roll number on the question paper.
2. Use of non-programmable scientific calculator is allowed.
3. Be Neat! Be Legible!! All the Best!!!

Multiple choice questions (Justify your answer)

Q1

(i) In the Steepest Descent Method for unconstrained optimization, the gradient vector is used because it provides information about:

3*1
(CO1,2,4)

- A. The curvature of the objective function
- B. The direction of maximum increase of the function
- C. The feasible region boundaries
- D. The second-order optimality conditions

(ii) In a Genetic Algorithm, crossover is primarily used to:

- A. Randomly alter genes to maintain diversity
- B. Remove weak individuals from the population
- C. Combine information from parent solutions to generate offspring
- D. Compute the fitness value of individuals

(iii) Assertion (A): Hessian matrix determines nature of stationary point

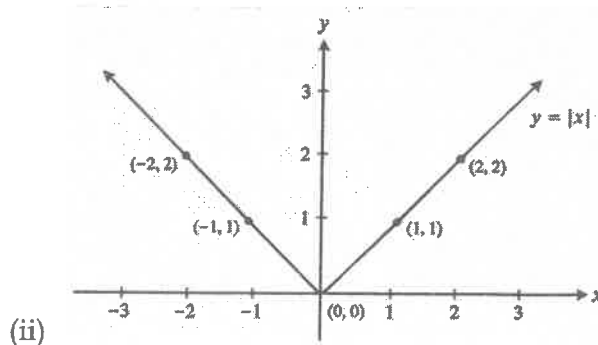
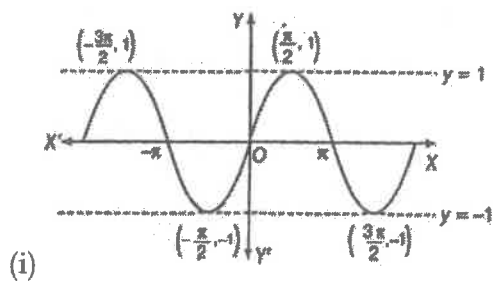
Reason (R): First derivative test is sufficient for determining optimality

- A. both true
- B. both false
- C. A true, R false
- D. A false B true

Q2

Identify the most suitable method for finding the optimum values of the following functions and justify your answer:

2.0
(CO2)



Q3

In a Genetic Algorithm, the population at the n^{th} generation is: {000, 000, 000, 000}

- (i) Identify the problem observed in this generation.
- (ii) Suggest one suitable solution to overcome this problem.

2.0
(CO4)

- Q4 A system engineer wants to minimize the cost function of a process by tuning a parameter x . The cost function is given by:
 $f(x) = x^2 - 10x + 30$; $0 \leq x \leq 10$
 Apply the Golden Section Search method to find the value of x that minimizes $f(x)$.
 Perform at least 4 iterations and present the results in a tabular form. 5.0
 (CO2,3)
- Q5 Minimize $f(x_1, x_2) = 4x_1^2 + 3x_2^2 - 4x_1x_2 - 8x_1 + 6x_2$, using the Conjugate Gradient Method. Given the initial point: $x^{(0)} = (0,0)$. 7.0
 Perform the iterations and obtain the optimal solution correctly up to three decimal places. (CO2,3)
- Q6 A smart city traffic control system is designed to minimize congestion at a major junction connecting two highways. The system regulates the number of vehicles allowed per minute on each route. Let x denote the number of vehicles per minute on Highway A and y denote the number of vehicles per minute on Highway B. The system must handle a minimum of 40 vehicles per minute, while the capacity of Highway A is limited to 25 vehicles per minute. Due to nonlinear congestion effects, the total delay (in seconds) is modeled as:
 $f(x, y) = x^2 + 3y^2 - 20x - 30y$
 Subjected to: Traffic demand and Capacity constraints which are as follows:
 $x + y \geq 40$
 $x \leq 25$
 and $x, y \geq 0$
 Formulate the **KKT conditions** for the above optimization problem. Based on the solution, is Highway A operating at full capacity? 7.0
 (CO1,2)
- Q7 A smart facility is distributing a fixed amount of energy across three subsystems x_1 , x_2 and x_3 , where x_1 represents energy supplied to lighting systems, x_2 represents the energy supplied to HVAC (heating, ventilation, and air conditioning) and x_3 represents the energy supplied to industrial machinery. Due to infrastructure limitations, the total effective energy consumption must satisfy:
 $x_1 + 2x_2 + 3x_3 = 15$
 and $x_1 \geq 0, x_2 \geq 0, x_3 \geq 0$
 The total energy loss is modeled as: $P = 2x_1^2 + x_2^2 + 3x_3^2$
 Determine the optimal distribution of energy using dynamic programming such that the total energy loss is minimized. 7.0
 (CO2)
- Q8 In an operating system, the performance of the CPU scheduler largely depends on the time quantum (q , in milliseconds). When q is too small, the system experiences excessive context switching overhead. When q is too large, the system suffers from poor response time. To model this trade-off, a simplified fitness (CPU performance) function is defined as:
 $f(q) = 80q - 2q^2$ where $q \in [1, 63]$.
 This function captures the balance between efficiency and overhead and the objective is to maximize CPU performance. Apply a Genetic Algorithm to maximize the fitness function $f(q)$ and identify the optimal time quantum for scheduling. Use the initial population {4, 17, 21, 30, 45, 60} generate two successive generations, perform one mutation during the second generation and evaluate the fitness of the resulting final population. 7.0
 (CO4)