

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



M. Tech. (Third Semester - Regular) Examinations, December – 2025
24MCSPE23001 – Optimization Techniques

Time: 3 hrs

Maximum: 60 Marks

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

PART – A**(2 x 5 = 10 Marks)**Q.1. Answer *ALL* questions

- | | CO # | Blooms
Level |
|---|------|-----------------|
| a. Define the feasible region in an optimization problem and explain how constraints determine this region. | CO1 | K1 |
| b. How does pheromone evaporation help in preventing premature convergence in ant colony optimization? | CO2 | K2 |
| c. In PSO, what do the terms personal best (pbest) and global best (gbest) represent? | CO3 | K3 |
| d. What is the objective function in a linear programming problem, and why must both the objective and constraints be linear? | CO4 | K1 |
| e. How does quadratic programming differ from integer programming in terms of the objective function and decision variables? | CO2 | K2 |

PART – B**(10 x 5 = 50 Marks)**Answer *ALL* the questions

- | | Marks | CO # | Blooms
Level |
|--|-------|------|-----------------|
| 2. a. A pharmaceutical company produces three types of medicines—M1, M2, and M3—using three types of ingredients, L1, L2, and L3. To manufacture one unit of M1, the company requires 3 units of L1, 2 units of L2, and 1 unit of L3; one unit of M2 requires 2 units of L1, 3 units of L2, and 4 units of L3; and one unit of M3 requires 4 units of L1 and 3 units of L3. The company has a total stock of 40 units of L1, 30 units of L2, and 45 units of L3. The profit per unit of M1, M2, and M3 is Rs. 8, Rs. 13, and Rs. 10 respectively. Formulate this scenario as a Linear Programming Problem (LPP) so that the company can maximize its profit. | 5 | CO1 | K1 |
| b. A manufacturing company has a contract to deliver 100, 250, 190, 140, 220, and 110 home windows over the next six months. Production cost per window varies by period and is estimated to be \$50, \$45, \$55, \$48, \$52, and \$50 over next 6 months. To take advantage of fluctuation in manufacturing cost, company can produce more windows than needed in a given month and hold the extra units for delivery in later months. This will incur a storage cost at rate of \$8 per window per month. Formulate the problem as a linear programming problem. | 5 | CO1 | K1 |

(OR)

- | | | | |
|---|---|-----|----|
| c. A ship has three cargo holds—forward, centre, and aft—with capacity limits of 2000 tonnes and 100,000 m ³ in the forward hold, 3000 tonnes and 135,000 m ³ in the centre hold, and 1500 tonnes and 30,000 m ³ in the aft hold. Three types of cargo—A, B, and C—are available, with maximum available amounts of 6000, 4000, and 2000 tonnes respectively. Their corresponding volumes per tonne are 60 m ³ , 50 m ³ , and 25 m ³ , and profits per tonne are Rs. 60, Rs. 80, and Rs. 50 respectively. The ship owners may accept all or any part of each cargo, but to preserve the ship's trim, the weight distribution in each hold must be proportional to its capacity in tonnes. Formulate a linear programming model to | 5 | CO1 | K2 |
|---|---|-----|----|

determine how much of each cargo should be loaded into each hold so as to maximize total profit.

- d. John must work at least 20 hours per week. To supplement his income while attending school, he has the opportunity to work in two retail stores. In store 1, he can work between 5 and 12 hours a week and in store 2 he can work between 6 and 10 hours. Both stores pay the same hourly wages. In deciding, how many hours to work in each store, John wants to base his decision on work stress, which are 8 and 6 respectively. Assume that total stress is proportional to the total number of hours, determine how many hours John should work in each store? 5 CO1 K2
- 3.a. A delivery company chooses number of trucks t (integer) and amount of fuel f (continuous) to minimize cost. Each truck costs \$1000 (integer t), fuel costs \$2 per liter (continuous f). Each truck requires 50 liters of fuel. A capacity constraint implies $20t + 5 \leq 100$. Also $f \geq 50t$. Formulate the problem and compute the optimal integer t and f that minimize total cost $1000t + 2f$. 5 CO2 K4
- b. A manufacturing company produces two products, A and B, using two limited resources: machining time and assembly time. Each unit of product A requires 2 hours of machining and 1 hour of assembly, while each unit of product B requires 1 hour of machining and 3 hours of assembly. The company has a total of 20 hours of machining time and 24 hours of assembly time available per week. Assuming that the quantities of A and B must both be non-negative, formulate the system of inequalities representing the feasible region and determine all the corner points of this feasible region. 5 CO2 K2

(OR)

- c. A farmer plans to grow two crops, X and Y, on his land and must allocate limited resources of fertilizer and pesticide. Each acre of crop X requires 3 units of fertilizer and 2 units of pesticide, while each acre of crop Y requires 1 unit of fertilizer and 4 units of pesticide. The farmer has a maximum of 30 units of fertilizer and 32 units of pesticide available. Considering that the acres allocated to each crop must be non-negative, formulate the constraints defining the feasible region, identify all feasible corner points, and compute the profit at each corner point if crop X gives ₹5000 profit per acre and crop Y gives ₹4000 per acre. 5 CO2 K3
- d. Find two non-negative numbers x and y such that $x + y = 20$ and the product $P = x^2 y$ is maximized. 5 CO2 K3
- 4.a. Minimize $Z = 5x + 2y$ subject to $3x + y \geq 9$, $x + 2y \geq 8$, $x, y \geq 0$. Solve using the graphical method and report the minimum value. 5 CO3 K4
- b. A company needs to produce a chemical mixture using two ingredients x_1 and x_2 . To meet quality standards, it must satisfy: $2x_1 + x_2 \geq 20$, $x_1 + 3x_2 \geq 30$ and $x_1 + x_2 \geq 0$. The cost per kg is ₹6 for ingredient x_1 and ₹4 for ingredient x_2 . Formulate the cost-minimization LPP and solve graphically to find the least-cost combination of x_1 and x_2 . 5 CO3 K3

(OR)

- c. A firm produces two products x_1 and x_2 . The constraints are: $x_1 + 2x_2 \leq 50$, $3x_1 + x_2 \leq 60$, and $x_1, x_2 \geq 0$. The profit contribution is ₹20 per unit of x_1 and ₹30 per unit of x_2 . Formulate the LPP and obtain the optimal solution using the graphical method. 5 CO3 K3
- d. A workshop manufactures tables and chairs. A table requires 4 hours of carpentry and 2 hours of painting, while a chair requires 2 hours of carpentry 5 CO2 K2

and 1 hour of painting. The workshop has a capacity of 80 hours of carpentry and 40 hours of painting per week. Profit per table is ₹70 and per chair is ₹30. Formulate the LPP and solve graphically to find how many tables and chairs should be made to maximize profit.

- 5.a. A delivery company wants to optimize a vehicle's delivery route using a Genetic Algorithm. The distances between five customer locations are provided in a matrix, and each chromosome represents a possible route. Suppose the fitness of four routes is calculated as 120 km, 140 km, 100 km, and 160 km, where a lower distance indicates better fitness. Convert these route distances into fitness scores using the formula $\text{fitness} = 1/\text{distance}$, normalize the fitness values, and determine which route has the highest probability of being selected for the next generation. 5 CO2 K3
- b. Two particles have current positions $x_1 = 2$ and $x_2 = 6$. Their personal bests are 1 and 5, respectively. The global best among them is 1. If both particles have a current velocity of 1 and the velocity update formula is $v_{\text{new}} = 0.4v + 0.6(\text{pbest} - x)$. 5 CO3 K2
- compute the updated velocities for both particles.
- (OR)
- c. A particle has a current position of $x = -3$ and velocity $v = 0$. Its personal best is -2 and the global best is -1. Using the rule $v_{\text{new}} = 0.2v + 0.5(\text{pbest} - x)$. Find the new velocity and the updated position. 5 CO3 K4
- d. An agricultural scientist is using a Genetic Algorithm to determine the optimal mixture of two fertilizers, A and B, to maximize crop yield. The yield function is $Y = 5a + 8b - (a^2 + b^2)$, where a and b represent the quantities of fertilizers A and B. The initial population contains the fertilizer combinations (1, 2), (2, 1), (3, 3), and (4, 2). Compute the yield for each chromosome, rank them according to fitness, and identify which two chromosomes should be selected as parents if rank-based selection is applied. 5 CO1 K4
- 6.a. Explain how quadratic programming is applied in portfolio optimization in finance. Give a simple example where two assets have known expected returns and risk levels, and ask how a quadratic objective function helps minimize risk while maximizing return. 5 CO4 K2
- b. Explain how genetic algorithms help in solving real-world scheduling problems, such as assigning employees to shifts. Give a small example showing how crossover and mutation can improve a poor schedule. 5 CO4 K3
- (OR)
- c. In image edge detection, ACO is used to trace high-intensity gradients in a digital image. Consider a 3×3 pixel grid where ants move from one pixel to another based on gradient intensity and pheromone values. Provide sample intensity values and initial pheromone levels for three possible pixel transitions. Ask the student to calculate the transition probability for each move using the ACO probability formula and explain how stronger edges attract more ants over iterations. 5 CO4 K2
- d. A factory produces two products using limited labor and raw materials. Describe how linear programming can be used to maximize profit. Provide a simple numerical scenario with two constraints and ask for the feasible region and optimal solution. 5 CO4 K3

--- End of Paper ---