Roll No. | | | | | | | | | | |

ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. / B. Tech / B. Arch (Full Time) - END SEMESTER EXAMINATIONS, APRIL / MAY 2024

Department of Industrial Engineering

VI Semester

IE5004- ADVANCED OPTIMIZATION TECHNIQUES

(Regulation 2019)

Time: 3hrs

Max. Marks: 100

CO 1	To impart knowledge to model and solve Integer programming problems.
CO 2	To model and solve problems using dynamic programming.
CO 3	To solve single- and multiple-variable unconstrained and constrained nonlinear.
CO 4	To solve non-linear problem using KKT condition, quadratic programming and separable programming.
CO 5	To apply meta heuristics for solving engineering problems

BL – Bloom's Taxonomy Levels
(L1 - Remembering, L2 - Understanding, L3 - Applying, L4 - Analyzing, L5 - Evaluating, L6 - Creating)

PART- A (10 x 2 = 20 Marks)

(Answer all Questions)

Q. No	Questions	Marks	CO	BL
1	Difference between goal and goal deviation? What are the types of goal deviation?	**2**	1	L1
2	What are the types of integer programming problems?	**2**	1	L2
3	What are the application of dynamic programming?	**2**	2	L2
4	State Bellman's principle of optimality?	**2**	2	L1
5	Difference between convex and concave function?	**2**	3	L1
6	What are the necessary condition to solving multi-variable unconstrained NLP?	**2**	3	L2
7	What is Hessian Matrix and give some example?	**2**	4	L1
8	Define Kuhn-tucker condition?	**2**	4	L1
9	What is meant by a metaheuristic algorithm? Name some algorithm.	**2**	5	L1
10	List the operating parameters of the genetic algorithm?	**2**	5	L2

PART- B (5 x 13 = 65 Marks)

<table>
<tr><th>Q. No</th><th>Questions</th><th>Marks</th><th>CO</th><th>BL</th></tr>
<tr><td>11 (a) (i)</td><td>Solve the following integer programming problem using the branch and bound method
Minimize $Z = 3X_1 + 2.5X_2$
subject to the constraints
(i) $X_1 + 2X_2 \geq 20$
(ii) $3X_1 + 2X_2 \geq 50$
$X_1, X_2 \geq 0$ and integers.</td><td>13</td><td>1</td><td>L3</td></tr>
<tr><td colspan="5">OR</td></tr>
<tr><td>11 (b) (i)</td><td>Use modified simplex method to solve the following GP problem
Minimize $Z = P_1^- + P_2(2d_2^- + d_3^-) + P_3 d_1^+$
subject to the constraints
(i) $X_1 + X_2 + d_1^- - d_1^+ = 400$
(ii) $X_1 + d_2^- = 200$
(iii) $X_1 + d_3^- = 300$
$X_1, X_2, d_1^-, d_1^+, d_2^-, d_3^- \geq 0$</td><td>13</td><td>1</td><td>L3</td></tr>
<tr><td>12 (a) (i)</td><td>Consider the problem of designing an electronic device that consists of three main components. The components are arranged in series so that the failure of one of them will result in the failure of the whole device. Therefore, it is decided that the reliability (probability of failure) of the device should be increased by installing parallel units on each component. Each component may be installed in, at the most, three parallel units. The total capital (in thousand Rs) available for the device is 10. The following data is available:
<table>
<tr><td rowspan="3">Number of Parallel Units, mi</td><td colspan="6">Components</td></tr>
<tr><td colspan="2">1</td><td colspan="2">2</td><td colspan="2">3</td></tr>
<tr><td>r1</td><td>c1</td><td>r2</td><td>c2</td><td>r3</td><td>c3</td></tr>
<tr><td>1</td><td>0.50</td><td>2</td><td>0.70</td><td>3</td><td>0.60</td><td>1</td></tr>
<tr><td>2</td><td>0.70</td><td>4</td><td>0.80</td><td>5</td><td>0.80</td><td>2</td></tr>
<tr><td>3</td><td>0.90</td><td>5</td><td>0.90</td><td>6</td><td>0.90</td><td>3</td></tr>
</table></td><td>13</td><td>2</td><td>L3</td></tr>
<tr><td colspan="5">OR</td></tr>
</table>

12 (b) (i)	An organization is planning to diversify its business with a maximum outlay of Rs. 5 crores. It has identified three different locations to install plants. The organization can invest in one or more of these plants subject to the availability of the fund. The different possible alternatives and their investment (in crores of rupees) and present worth of returns during the useful life (in crores of rupees) of each of these plants are summarized in table. The first row of table has zero cost and zero return for all the plants. Hence, it is known as do-nothing alternative. Find the optimal allocation of the capital to different plants which will maximize the corresponding sum of the present worth of returns	**13**	2	L3

Alternative	Plant 1		Plant 2		Plant 2	
	cost	return	cost	return	cost	return
1	0	0	0	0	0	0
2	1	15	2	14	1	3
3	2	18	3	18	2	7
4	4	28	4	21	-	-

13 (a) (i)	Solve the following single – variable unconstrained problem Maximize $f(x) = 8X - 3X^2 + X^3 - 2X^4 - X^6$	**13**	3	L4
	OR			
13 (b) (i)	Minimize $f(x_1, x_2) = X_1 - X_2 + 2X_1^2 + 2X_1 X_2 + X_2^2$, starting from the point $X_1 = (0,0)$ using Fletcher Reeves method	**13**	3	L4
14 (a) (i)	Solve the following nonlinear programming problem using Kuhn-Tucker conditions. Minimize $Z = 8X_1 + 10X_2 - X_1^2 - X_2^2$ subject to the constraints (i) $3X_1 + 2X_2 \leq 6$ $X_1, X_2 \geq 0$	**13**	4	L4
	OR			
14 (b) (i)	Use Beale's method to solve quadratic programming problem: Maximize $Z = 2X_1 + 3X_2 - 3X_2^2$ subject to the constraints (i) $X_1 + 4X_2 \leq 4$ (ii) $X_1 + X_2 \leq 2$ $x1, x2 \geq 0$	**13**	4	L4

15 (a) (i)	Explain the procedure of simulated annealing algorithm with an example.	**13**	5	L3
	OR			
15 (b) (i)	Draw the flow chart of Genetic Algorithm and explain the steps with numerical illustration.	**13**	5	L3

PART- C (1 x 15 = 15 Marks)

(Q.No.16 is compulsory)

Q. No	Questions	Marks	CO	BL
16.	Solve the following integer programming problems, using Gomory's cutting plane algorithm: Max $Z = 2X_1 + 1.7X_2$ subject to (a) $4X_1 + 3X_2 \leq 7$ (b) $X_1 + X_2 \leq 4$ $X_1, X_2 \geq 0$ and integers.	**15**	1	L5