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Reg. No.................................

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B.Sc. DEGREE (C.B.C.S.S.) EXAMINATION, MAY 2024

Fourth Semester

Complementary Course—OPERATIONS RESEARCH—NON-LINEAR PROGRAMMING

(For B.Sc. Mathematics—Model II)

[2013–2016 Admissions]

Time : Three Hours | Maximum Marks : 80

Part A

Answer **all** *questions.*
Each question carries 1 *mark.*

1. Define Integer Programming.
2. What is the difference between Integer programming and Linear programming ?
3. Can integer programming problems be solved by rounding off the corresponding simplex solution.
4. What do you mean by 0-1 programming ?
5. What is a non-linear programming problem ?
6. Define a concave function.
7. Write the matrix form of a non-linear programming problem.
8. Define saddle value problem.
9. Define a positive definite quadratic form.
10. Define quadratic programming problem.

$(10 \times 1 = 10)$

Part B

Answer any **eight** *questions.*
Each question carries 2 *marks.*

11. Write a short note on Gomory's cutting plane algorithm.
12. What are the applications of integer programming models ?
13. What are the constraints of the sub-problems of an integer linear programming problem with respect to branch and bound method ?
14. How does quadratic programming problem differ from the linear programming problem ?

Turn over

15. What are the applications of non-linear programming ?

16. What is the relation between a saddle point of F(X, Y) and a minimal point of F(X) with respect to a convex programming problem ?

17. Show that if X^TQX is positive definite them it is strictly convex for all $X \in R^n$, where Q is an $n \times n$ real symmetric matrix.

18. Define a separable function.

19. State the sufficient conditions for non-negative saddle points.

20. Check whether the function $f(x_1, x_2, x_3) = x_1^3 - 2x_1^2 + 4x_1 + 3x_2^4 - 4x_2 + 5\sin(x_3 + 1)$ separable.

21. Explain Kuhn Tucker conditions.

22. Define separable programming problem.

(8 × 2 = 16)

Part C

Answer any **six** *questions.*
Each question carries 4 *marks.*

23. Find the optimum integer solution to the following all integer programming problem :

Maximize $Z = x_1 + x_2$

subject to the constraints

$$3x_1 + 2x_2 \leq 5$$
$$x_2 \leq 3$$

$x_1, x_2 \geq 0$ and are integers.

24. Suppose five items are to be loaded on the vessel. The weight W, volume V and price P are tabulated below. The maximum cargo weight and cargo volume are W = 112, V = 109 respectiely. Determine the most valuable cargo load in discrete unit of each item :

Item		W	V	Price (in Rs.)
1	…	5	1	4
2	…	8	8	7
3	…	3	6	6
4	…	2	5	5
5	…	7	4	4

Formulate the problem as an integer programing model.

25. Find the optimum integer solution to the following all integer programming problem :

Maximize $Z = x_1 + 2x_2$

subject to $x_1 + x_2 \leq 7$

$2x_1 \leq 11$

$2x_2 \leq 7$

$x_1, x_2 \geq 0$ and are integers.

26. Obtain the set of necessary conditions for the non-linear programming problem :

Maximize $Z = x_1^2 + 3x_2^2 + 5x_3^2$

subject to the constraints

$x_1 + x_2 + 3x_3 = 2$

$5x_1 + 2x_2 + x_3 = 5$

$x_1, x_2, x_3 \geq 0$

27. Examine $Z = 6x_1x_2 - 10x_3$ for maxima and minima under the constraint equation $3x_1 + x_2 + 3x_3 = 10$.

28. Explain the role of Lagrange multipliers in a non-linear programming problem.

29. Show that K-T conditions fail to give maximum x_1, subject to

$$(1 - x_1)^3 - x_2 \geq 0, \; x_1 \geq 0, \; x_2 \geq 0.$$

30. Solve graphically the non-linear programming problem :

Maximize $Z = x_1$

subject to the constraints :

$$(3 - x_1)^3 - (x_2 - 2) \geq 0$$

$$(3 - x_1)^3 + (x_2 - 2) \geq 0$$

$$x_1, x_2 \geq 0.$$

31. Explain Wolfes's method of solving a quadratic programming problem.

(6 × 4 = 24)

Turn over

Part D

Answer any **two** *questions.*
Each question carries 15 *marks.*

32. Use Branch and Bound technique to solve the following integer programming problem :

Maximize $Z = 3x_1 + 3x_2 + 13x_3$

subject to the constraints

$$-3x_1 + 6x_2 + 7x_3 \leq 8$$
$$5x_1 - 3x_2 + 7x_3 \leq 8$$
$$0 \leq x_j \leq 5, \text{ all } x_j \text{ are integers for } j = 1, 2, 3.$$

33. Use Wolfe's method to solve the quadratic programming problem :

Maximize $Z = 2x_1 + 3x_2 - 2x_1^2$

subject to the constraints

$$x_1 + 4x_2 \leq 4$$
$$x_1 + x_2 \leq 2$$
$$x_1, x_2 \geq 0.$$

34. Use separable convex programming to solve the problem :—

Maximize $Z = 3x_1^2 + 2x_2^2$

subject to

$$x_1^2 + x_1^2 \leq 25$$
$$9x_1 - x_2^2 \leq 27, \quad x_1, x_2 \geq 0.$$

35. Use K.T conditions to solve the problem :

Maximize $Z = 2x_1^2 + 12x_1x_2 - 7x_2^2$

subject to the constraints

$$2x_1 + 5x_2 \leq 98$$
$$x_1, x_2 \geq 0.$$

(2 × 15 = 30)