

Total No. of printed pages = 3

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2022

BINA CHOWDHURY OPTICAL LIBRARY
(GMT & GIPS)

Azara, Hatkhowapara,
Guwahati - 781017

B.Tech. 6th Semester End-Term Examination

OPTIMIZATION TECHNIQUES IN ENGINEERING

(New Regulations & New Syllabus)

Full Marks – 70

Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer question No. 1 and any four from the rest.

1. Select the most appropriate answer/fill in the blank/complete the sentence: (10 × 1 = 10)
- (i) A Hessian matrix is negative definite if
 - (a) all its principal minors are negative
 - (b) the odd principal minors are negative and even principal minors are positive
 - (c) the odd principal minors are positive and the even principal minors are negative
 - (d) none of the above
 - (ii) In case of minimization problem, for a positive value of Lagrange's multiplier λ^* , a unit decrease in b will
 - (a) improve the objective function
 - (b) deteriorate the objective function
 - (c) both (a) and (b)
 - (d) none of the above
 - (iii) The full form of KKT in KKT conditions _____.
 - (iv) The distinguishing feature of LP model is
 - (a) relationship among all variables is linear
 - (b) it has single objective function and multiple constraints
 - (c) values of the decision variables are non-negative
 - (d) all of the above

[Turn over

- (v) An LPP has alternate optimum solution if the indicator row value of a _____ is _____.
- (vi) Degeneracy in LPP occurs when _____.
- (vii) With reference to duality in LPP, the dual objective function coefficients equal _____.
- (viii) Elimination methods assumes the functions to be _____ ones.
- (ix) Fletcher and Reeve's method uses the concept of _____ to find the minimum of a function.
- (x) Dynamic programming is a _____ decision making process.
2. (a) Find the maxima and minima, if any, of the function
 $f(X) = 4x^3 - 18x^2 + 27x - 7.$ (5)
- (b) It has been decided to leave a margin of 30 mm at the top and 20 mm each at the left side, right side, and the bottom on the printed page of a book. If the area of the page is specified as $5 \times 10^4 \text{ mm}^2$, use classical optimization technique to determine the dimensions of a page that provide the largest printed area. (10)
3. (a) State the sufficient conditions for optimization of (i) a single variable, and (ii) a multi-variable function without constraints. (3)
- (b) Use KKT conditions to maximize the following function,
 $f(X) = 2x_1 - x_1^2 + x_2$
 Subject to : $2x_1 + 3x_2 \leq 6$
 $2x_1 + x_2 \leq 4, x_1, x_2 \geq 0$ (12)
4. (a) What is 'standard form' of LPP? Explain how an LPP is converted into standard form. (3)
- (b) The final product of a firm has a requirement that it must weight exactly 150 kg. The two raw materials used in the manufacture of this product are A with a cost of \$2 per unit and B with a cost of \$8 per unit. At least 14 units of B and no more than 20 units of A must be used. Each unit of A weights 5 kg and each unit of B weights 10 kg. Formulate the problem as LPP to minimize the cost of the final product, and solve it graphically. (4+8)

5. Solve the following LPP by Simplex method:

$$\text{Maximize } Z = 5x_1 + 12x_2 + 4x_3$$

Subject to

$$x_1 + 2x_2 + x_3 \leq 5$$

$$2x_1 - x_2 + 3x_3 = 2$$

$$\text{and } x_1, x_2, x_3 \geq 0.$$

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From the optimum solution,

- (a) Discuss the effect of changing the RHS constants from (5,2) to (7,2).
- (b) Which resource should be increased and by how much to achieve the best marginal increase in the value of the objective function?

6. (a) What are one-dimensional minimization methods? Why are they called so? (1+2)
- (b) What is the essential difference between 'Fibonacci search method' and 'Golden section method'? Which is the better method of the two? Discuss. (3)
- (c) Why is the steepest descent direction not efficient in practice, although the directions used are the best directions? (2)
- (d) Explain briefly the term 'conjugate directions'? Illustrate how the search directions are generated in 'Fletcher-Reeves' method. (2+5)

7. Solve the following quadratic programming problem by Wolf's method (15)

$$\text{Maximize } Z = 15x_1 + 30x_2 + 4x_1x_2 - 2x_1^2 - 4x_2^2$$

$$\text{Subject to } x_1 + 2x_2 \leq 30$$

$$\text{and } x_1, x_2 \geq 0.$$