M.Tech. Mechanical Engineering Design (CBCS) Semester-II

MED23 - Optimization Techniques in Design

P. Pages : 2 **GUG/S/25/14195**

Time : Three Hours * 2 4 8 9 * Max. Marks : 70

Notes : 1. All questions carry marks as indicated.
2. Due credit will be given to neatness and adequate dimensions.
3. Assume suitable data wherever necessary.
4. Diagrams and Chemical equation should be given wherever necessary.
5. Illustrate your answers wherever necessary with the help of neat sketches.
6. Retain all construction lines.
7. Solve **any five** questions.
8. Use of Random number chart, normal standard distribution table is permitted.

1. Ms. Fidan's diet requires that all the food sheets come from one of the four "basic food groups". At present, the following four foods are available for consumption: brownies, chocolate ice cream, cola, and pineapple cheesecake. Each brownie costs 0.5$, each scoop of chocolate ice cream costs 0.2$, each bottle of cola costs 0.3$, and each pineapple cheesecake costs 0.8$. Each day, she must invest at least 500 calories, 6 oz of chocolate, 10 oz of sugar, and 8 oz of fat. The nutritional content per unit of each food is shown in Table. Formulate an LP model that can be used to satisfy her daily nutritional requirements at minimum cost. **14**

	Calories	Chocolate (ounces)	Sugar (ounces)	Fat (ounces)
Brownie	400	3	2	2
Choc.	200	2	2	4
Cola (l bottle)	150	0	4	1
Pineapple cheesecake (1)	500	0	4	5

2. a) Explain with suitable example of Lagrangian Multiplers Method. **7**

Use the method Fibonacci to minimize $f(x_1, x_2) = 4(x_1)^2 + 6(x_2 - 6)^2$

The initial simplex has the following three vertices A(8, 9), B(10, 11) and C(8, 11)

b) Explain Graphical representation in optimization technique. **7**

3. A manufacturing firm produces two products, A and B, using two limited resources. The maximum amounts of resources 1 and 2 available per day are 1000 and 250 units, respectively. The production of 1unit of product A requires 1 unit of resource 1 and 0.2 unit of resource 2 and the production of 1 unit of product B requires 0.5 unit of resource 1 and 0.5 unit of resource 2. The unit costs of resources 1 and 2 are given by the relations (0.375 - 0.00005u1) and (0.75 - 0.0001u2), respectively, where u_i denotes the number of units of resource i used (i = l, 2). The selling prices per unit of products A and B, pA and pB, are given by **14**

pA = 2.00 – 0.0005xA – 0.00015xB

pB = 3.50 – 0.0002xA – 0.0015xB

where xA and xB indicate, respectively, the number of units of products A and B sold. Formulate the problem of maximizing the profit assuming that the firm can sell all the units it manufactures.

SOLUTION Let the design variables b.

4. A retail store stocks and sells three different models of TV sets. The store cannot afford to have an inventory worth more than \$45,000 at any time. The TV sets are ordered in lots. It costs \$aj for the store whenever a lot of TV model j is ordered. The cost of one TV set of model j is cj . The demand rate of TV model j is dj units per year. The rate at which the inventory costs accumulate is known to be proportional to the investment in inventory at any time, with qj = 0.5, denoting the constant of proportionality for TV model j . Each TV set occupies an area of $sj = 0.40\,m^2$ and the maximum storage space available is $90\,m^2$. The data known from the past experience are given below. **14**

TV MODEL -J	1	2	3
Order list aj (Rs)	50	80	100
Unit cost cj (Rs)	40	120	80
Demand rate dj(Rs)	800	400	1200

Formulate the problem of minimizing the average annual cost of ordering and storing the TV sets.

5. a) A uniform column of rectangular cross section is to be constructed for supporting a water tank of mass M. It is required (1) to minimize the mass of the column for economy and (2) to maximize the natural frequency of transverse vibration of the system for avoiding possible resonance due to wind. Formulate the problem of designing the column to avoid failure due to direct compression and buckling. Assume the permissible compressive stress to beσ_{max} . **10**

b) Define geometric programming of constraint programming problem. **4**

6. a) Describe and graph the regions in the first quadrant of the x_1x_2. plane determined by the given inequalities $x_1 - x_2 \geq -6, x_1 + x_2 \leq 6$. **7**

b) Describe and graph the regions in the first quadrant of the x_1x_2. plane determined by the given inequalities $x_1 + x_2 \geq 2, 3x_1 + 5x_2 \geq 15$. **7**

7. A fertilizer mixing plant produces two fertilizers, A and B, by mixing two chemicals, Cl and C2, in different proportions. The contents and costs of the chemicals Cl and C2 are as follows: **14**

Chemical	Ammonia	Phosphates	Cost (\$/lb)
C1	0.70	0.30	5
C2	0.40	0.60	4

Fertilizer A should not contain more than 60% of ammonia and B should contain at least 50% of ammonia. On the average, the plant can sell up to 1000 lb/hr and due to limitations on the production facilities, not more than 600 lb of fertilizer A can be produced per hour. The availability of chemical C1 is restricted to 500 lb/hr. Assuming that the production costs are same for both A and B, determine the quantities of A and B to be produced per hour for maximum return if the plant sells A and B at the rates of \$6 and \$7 per pound.

8. a) What is unconstrained optimization? Constraint optimization? To which one do methods of calculus apply? **7**

b) What is the basic idea of linear programming? **7**

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