

M.Tech. Mechanical Engineering Design (CBCS Pattern) Semester-II
MED23 - Optimization Techniques in Design

P. Pages : 2

Time : Three Hours



GUG/W/24/14195

Max. Marks : 70

- Notes :
1. All questions carry marks as indicated.
 2. Assume suitable data wherever necessary.
 3. Diagrams and Chemical equation should be given wherever necessary.
 4. Illustrate your answers wherever necessary with the help of neat sketches.
 5. Use of slide rule, Logarithmic tables, Steam tables, Mollier's chart, Drawing instruments, Thermodynamic tables for moist air, Psychrometric charts and Refrigeration charts is permitted.
 6. Solve **any five** questions.
 7. Due credit will be given to neatness.
 8. Use of Random number chart, normal standard distribution table is permitted.

1. a) Let the function f be of class C^2 on an open set $O(0 \in \mathbb{R}^n)$ and $X_0 \in O$ a critical point 7
Then Prove that $f(x_1, x_2) = x_1^4 + 2x_1^2x_2^2 + x_2^4$
- b) What your idea about programming and Graphical representation in Optimization technique. 7
2. a) Write down the characteristic of optimization technique with constraint problem. 7
b) Show that, successive gradients are orthogonal (perpendicular). Why and what happens if you apply the method of steepest descent to $F(x) = x_1^2 + x_2^2$? First guess, then calculate. 7
3. a) Explain the problem using the example with the constraints interchanged. 7
b) Suppose we produce x_1 AA batteries by Process P_1 and x_2 by process P_2 , furthermore x_3 A batteries by Process P_3 and x_4 by process P_4 . Let the profit for 100 batteries be zero rupees for AA and zero rupees for A. Maximize the total profit subject to the constraints. 7
 $12x_1 + 8x_2 + 6x_3 + 4x_4 \leq 120 \leq (\text{material})$
 $3x_1 + 6x_2 + 12x_3 + 24x_4 \leq 180 \leq (\text{labour})$
4. Ms. Fidan's diet requires that all the food she eats come from one of the four "basic food groups". At present, the following four foods are available for consumptions: 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
Choco ice cream (1 scoop)	200	2	2	4
Cola (1 bottle)	150	0	4	1
Pineapple cheesecake (1 piece)	500	0	4	5

5. A Post Office requires different numbers of employees on different days of the week. Union rules state each employee must work 5 consecutive days and then receive two days off. Find the minimum number of employees needed. **14**

	Mon	Tue	Wed	Thur	Fri	Sat	Sun
Staff Needed	17	13	15	19	14	16	1

6. In a cargo-loading problem, there are four items of different weight per unit and value as shown below. The maximum cargo load is restricted to 17 units. How many units of each item is loaded to maximize the value. **14**

Item	Weight (w_i)	Value per unit
1	1	1
2	3	5
3	4	7
4	6	11

7. a) Sailco must determine how many sailboats to produce in the next 4 quarters. The demand is known to be 40, 60, 75 and 25 boats. Sailco must meet its demands. At the beginning of the 1st quarter Sailco starts with 10 boats in inventory. Sailco can produce up to 40 boats with regular time labor at \$400 per boat, or additional boats at \$450 with overtime labor. Boats made in a quarter can be used to meet that quarter's demand or held in inventory for the next quarter at an extra cost of \$20.00 per boat. **7**

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

8. Solve the problem **14**

$$\text{Minimise } f(x) = 6x_1x_2^{-1} + x_2x_1^{-2}$$

$$\text{Subject to } h(x) = x_1x_2 - 2 = 0$$

$$g(x) = x_1 + x_2 - 1 \geq 0$$

Using the constrained optimization method with initial metric $H^0=1$
