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ME 131703

Roll No. of candidate

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2017

B.Tech. 7th Semester End-Term Examination

Mechanical

SYSTEM OPTIMIZATION TECHNIQUES

Full Marks – 100

Time – Three hours

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

Answer Question No. 1 and any *six* from the rest.

1. Choose the correct solution : (10 × 1 = 10)
- (a) The best use of a linear programming technique is to find an optimal use of
 - (i) Money
 - (ii) Manpower
 - (iii) Machine
 - (iv) All of the above
 - (b) Non-negativity condition is an important component of LP model because
 - (i) Variables value should remain under the control of the decision-maker
 - (ii) Value of variables make sense and correspond to real-world problems
 - (iii) Variables are interrelated in terms of limited resources
 - (iv) None of the above

[Turn over

- (c) A feasible solution to an LP problem
- (i) Must satisfy all of the problems constraint simultaneously
 - (ii) Need not satisfy all of the constraints
 - (iii) Must be a corner point of the feasible region
 - (iv) Must optimize the value of the objective function
- (d) While solving a LP model graphically, the area bounded by the constraints is called
- (i) Unbounded solution
 - (ii) Infeasible region
 - (iii) Feasible region
 - (iv) None of the above
- (e) If an optimal solution is degenerate, then
- (i) There are alternative optimal solutions
 - (ii) The solution is infeasible
 - (iii) The solution is of no use to the decision-maker
 - (iv) One of the basic variable becomes zero
- (f) For a maximization problem, the objective function coefficient for an artificial variable is
- (i) +M
 - (ii) -M
 - (iii) Zero
 - (iv) None of the above

- (g) If a negative value appears in the solution values (x_b) column of the simplex table, then
- (i) The solution is optimal
 - (ii) The solution is unbounded
 - (iii) The solution is infeasible
 - (iv) There exist an alternate solution
- (h) If an artificial variable is present in the "basic variable" column of optimal simplex table, then the solution is
- (i) Infeasible
 - (ii) Unbounded
 - (iii) Degenerate
 - (iv) Optimal
- (i) A variable which does not appear in the basic variable column (b) of simplex table is
- (i) Never equal to zero
 - (ii) Always equal to zero
 - (iii) Called a basic variable
 - (iv) Called a decision variable
- (j) At every iteration of a simplex method, for minimization problem, a variable in the current basis is replaced with another variable that has
- (i) A positive $C_j - Z_j$ value
 - (ii) A negative $C_j - Z_j$ value
 - (iii) $C_j - Z_j$ value is zero
 - (iv) $Z_j \leq 0$

2. (a) What is the limitation of using a graphical method? (2)
- (b) What do you mean by feasible, unbounded and alternate solution as referred to graphical methods? (3)
- (c) A diet for a sick person must contain atleast 4000 units of vitamins, 50 units of minerals and 1400 calories. Two foods A and B are available at a cost of Rs. 4 and Rs. 3 per unit, respectively. If one of A contains 200 units of vitamins, 1 unit of minerals and 40 calories and one unit of food B contains 100 units of vitamins, 2 units of minerals, and 40 calories, formulate this problem as an LP model and solve it by graphical method to find combination of foods to be used to have least cost. (10)

3. An Air-Force is experimenting with three types of bombs P, Q and R in which three kinds of explosives. viz. A, B and C will be used. Taking the various factors into account, it has been decided to use the maximum 600 kg of explosive A, at least 480 kg of explosive B and exactly 540 kg of explosive C. Bomb P requires 3, 2, 2 kg, bomb Q requires 1, 4, 3 kg and bomb R requires 4, 2, 3 kg of explosives A, B and C respectively. Bomb P is estimated to give the equivalent of a 2 ton explosion, bomb Q a 3 ton explosion and bomb R a 4 ton explosion respectively. Use Big-M method to investigate under what production schedule the Air Force can make the biggest bang. (15)

4. XYZ tobacco company purchase tobacco and stores warehouses located in the following four cities :

Warehouse city : A B C D

Capacity (Tonnes) : 90 50 80 60

The warehouses supply tobacco to cigarette companies in three cities that have the following demand :

Cigarette company : Bharat Janta Red Lamp

Demand (Tonnes) : 120 100 110

The following railroad shipping costs per tonne (in hundred rupees) have been determined :

	To Bharat Janta Red Lamp		
From			
A	7	10	5
B	12	9	4
C	7	3	11
D	9	5	7

Because of railroad construction, shipments are temporarily prohibited from warehouse at city A to Bharat Cigarette company.

- (a) Find the optimum distribution for XYZ tobacco Company.
- (b) Are there multiple optimum solutions? If there are alternative optimum solutions, identify them. (15)

5. (a) ABC Ice Cream Company has a distribution depot in Greater Kialash Part I for distributing ice-cream in South Delhi. There are four vendors located in different parts of South Delhi (call them A, B, C and D) who have to be supplied ice-cream everyday. The following matrix displays the distances (in kilometres) between the depot and the four vendors :

From \ To	Depot	Vendor A	Vendor B	Vendor C	Vendor D
Depot	-	3.5	3	4	2
Vendor A	3.5	-	4	2.5	3
Vendor B	3	4	-	4.5	3.5
Vendor C	4	2.5	4.5	-	4
Vendor D	2	3	3.5	4	-

What route should the company van follow visiting all the vendors so that the total distance travelled is minimized? (10)

- (b) Explain how an assignment problem is different from the transportation problem. (5)

6. ABC airlines operating 7 days a week has given the following time table :

Departure from Guwahati	Route No.	Arrival at Delhi	Departure from Delhi	Route No.	Arrival at Guwahati
06:00	A1	08:00	08:00	B1	10:00
08:00	A2	10:00	09:00	B2	11:00
14:00	A3	16:00	14:00	B3	16:00
20:00	A4	22:00	19:00	B4	21:00

Crew must have a minimum layover of 5 hours between flights. Obtain the pairing flights that minimizes layover time away from home. For any given pairing the crew will be based at the city that results the smallest layover. (15)

7. Solve the following Integer programming problem using Gomory's cutting plane algorithm. (15)

$$\text{Maximize } Z = x_1 + x_2$$

$$\text{Subject to constraints, } 3x_1 + 2x_2 \leq 5$$

$$x_2 \leq 2$$

$$x_1, x_2 \geq 0 \text{ and are integers}$$

8. (a) Using KKT method solve : (8)

$$\text{Minimize } Z = x_1^2 + x_2^2$$

$$\text{Subject to constraints, } x_1 + x_2 \geq 4$$

$$2x_1 + x_2 \geq 5$$

$$x_1, x_2 \geq 0$$

- (b) Using Lagrangean method solve : (7)

Optimize

$$Z = 2x_1^2 + x_2^2 + 3x_3^2 + 10x_1 + 8x_2 + 6x_3 - 100$$

$$\text{Subject to constraints, } x_1 + x_2 + x_3 = 20$$

$$x_1, x_2, x_3 \geq 0$$

Does the solution maximize or minimize the objective function?

9. (a) "Inventory is a necessary evil". Explain (5)

(b) A cast iron bracket has a demand of 9000 units per year. The cost of one procurement is Rs. 100 and the holding cost per unit is Rs. 2.40 per year. The company operates for 300 days per year. The replacement is instantaneous and no shortage is allowed. Help the purchase manager to determine an ordering policy for raw materials to find optimal lot size, number of orders per year, time between orders, yearly variable inventory cost and yearly total inventory cost if Rs. 3 is the cost of one item.

(10)