

14. Indication of existence of multiple solution by simplex method is that

- (i) Element of $Z_j - C_j$ row corresponding to basic variable is zero
- (ii) Element of $Z_j - C_j$ row corresponding to non-basic variable is zero
- (iii) Element of $Z_j - C_j$ row corresponding to slack variable is zero
- (iv) Element of $Z_j - C_j$ row corresponding to surplus variable is zero

15. In two phase method, II-phase is used to find _____
 [Feasible optimal solution, _____ feasible solution,
 multiple solutions, _____ whether feasible solution exists]

16. The objective function of traveling salesman problem is _____

$$[\text{Minimize } Z = \sum_{j=1}^n \sum_{i=1}^n c_{ij} x_{ij}$$

$$\text{Minimize } Z = \sum_{j=1}^{n+1} \sum_{i=1}^n c_{ij} x_{ij}$$

$$\text{Minimize } Z = \sum_{i=1}^{n+1} \sum_{j=1}^{n-1} c_{ij} x_{ij}$$

$$\text{Minimize } Z = \sum_{i=1}^{n-1} \sum_{j=1}^n c_{ij} x_{ij}]$$

17. Branch and bound method of integer programming problem is referred to

- a. Adding a constraint,
- b. Removing a constraint,
- c. Either adding or removing a constraint,
- d. Removing constraint and extending the feasible solution region

18. $\text{Max } Z = 6x_1 + 4x_2 + 8x_3$ subject to the constraints $x_1 + x_2 \geq 5$, $x_2 \geq 8$, $9x_1 + 10x_2 \leq 15$;
 $x_1, x_2, x_3, \geq 0$ has the auxiliary objective function for two phase method is _____

$$[\text{Min } Z = -A_1 - A_2 - A_3$$

$$\text{Min } Z = A_1 + A_2 + A_3,$$

$$\text{Max } Z = -A_1 - A_2,$$

$$\text{Max } Z = A_1 * A_2]$$

19. The rate by objective function value improves as the R.H.S quantity is increased by unity is called

[Reduced cost, Opportunity cost, Relative cost, Dual price]

20. Which one is not the terminology of integer programming problem _____

- a. Node
- b. Fathom
- c. Feasible region
- d. Cutting plane

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Semester : I
F.M. : 50

SECTION "C"

[3 Q.×7=21 marks]

1. State basic characteristics of queueing system. In a car-wash service facility, cars arrive for service according to Poisson distribution with mean 6 per hour. The time for washing and cleaning each car has exponential distribution mean 20 minutes per car. The facility cannot handle more than one car at a time and has a total of 5 parking spaces construct the network diagram for the project [1+3+3]
- a) Find the probability that an arriving car will get service immediately upon arrival
- b) Find the expected number of parking spaces occupied.
2. The owner of KFC with branches in the country is considering a new computer system for accounting and inventory control. A computer company sent the following information about the computer installation: [3+2+2]

			Times(days)
A	Select the computer model	---	14
B	Design input/output systems	A	20
C	Design monitoring systems	B	10
D	Assemble computer hardware	B	6
E	Develop the main programs	B	12
F	Develop input/output routines	C	10
G	Create data base	C	6
H	Install the system	F,G	8
I	Test and packaging	D,E,H	16
J	Supply to branch restaurants	I	15

- a) Construct the network diagram for the project
- b) Find the expected completion time of the project
- c) Find the total floats for all the non-critical activities
3. The production of a certain manufacturing firm involves a machining process that requires raw materials and then converts them into (unassembled parts. These parts are then sent to one of the two divisions for being assembly into the final product .Division 1 is used for product X, and Division 2 for product Y. Product X requires 40 units of raw material and 10 hours of machine processing time .Product Y requires 80 units of raw material and 4 hours of machine processing time. During the period, 800 units of raw material and 80 hours of machine processing time are available. The capabilities of the two assembly division during the period are 6 and 9 units respectively. The profit contribution per unit to profit and overhead (fixed costs) is of Rs.200 for each unit of product X and of Rs.120 for each unit of product Y (a) Formulate the problem as the linear programming problem (b) determine the optimal level of product for the two products using the graphical method. [3.5+3.5]

OR

When do we enter phase II in the process of solving LP-problem by Two –Phase Method? Find the optimal solution of the following LP-problem by using Two-phase method: [1+6]

$$\begin{aligned} \text{Minimize } Z = 5x_1 + 8x_2 \text{ subject to } & 3x_1 + 2x_2 \geq 3 \\ & x_1 + 4x_2 \geq 4 \\ & x_1 + x_2 \leq 5 \\ & x_1, x_2 \geq 0 \end{aligned}$$

SECTION “D”

[5 Q. × 5= 25 marks]

4. What sort of LP problem does the dual-simplex method solve? By using this method find the optimal solution of following LP-problem: [1+4]

$$\begin{aligned} \text{Minimize } Z = 3x_1 + x_2 \text{ subject to } & x_1 + x_2 \geq 1 \\ & 2x_1 + 3x_2 \geq 2 \\ & x_1, x_2 \geq 0 \end{aligned}$$

5. What is the significance of Big-M that is used in Big-M technique of Simplex method? By using this technique find the optimal solution of the following LP-problem: [1+4]

$$\text{Maximize } Z = 2x_1 + 3x_2 + 4x_3 \text{ subject to } 3x_1 + x_2 + 4x_3 \leq 600$$

$$\begin{aligned} & 2x_1 + 4x_2 + 2x_3 \geq 480 \\ & 2x_1 + 3x_2 + 3x_3 = 450 \\ & x_1, x_2, x_3 \geq 0 \end{aligned}$$

OR

Find the optimal integer solution of the following integer programming problem by using Gomory’ s cutting plane method [5]

$$\begin{aligned} \text{Max } Z = x_1 + x_2 \text{ subject to } & 3x_1 + 2x_2 \leq 5 \\ & x_2 \leq 2, \quad x_1, x_2 \geq 0 \text{ and integers} \end{aligned}$$

6. A company has factories at different places 1,2,3,4 which supply items to warehouses A,B,C,D,E. Monthly factory capacities are 200 ,175 ,150 ,325 ,respectively. Monthly warehouse requirements are 110, 90, 120, 230, and 160, respectively. Unit shipping costs (in rupees) are given in the following table: Find optimal distribution plan of items by using initial solution by Vogel’s Approximation solution. [5]

Place	Warehouse				
	A	B	C	D	E
1	13	---	31	8	20
2	14	9	17	26	10
3	25	11	12	17	15
4	10	21	13	---	17

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7. A salesman has to visit five cities A, B, C, D, E the times (in hours) between the five cities are as follows: If the salesman starts from city A and has to come back to city A. Find the optimal routing schedule so that time of travelling is minimum. [5]

Place ↓	Warehouse				
	A	B	C	D	E
A	--	1	6	6	4
B	7	--	8	5	6
C	6	8	--	9	7
D	8	5	9	---	8
E	4	6	7	8	---

8. In a single channel queuing system random numbers for arrivals of customers are 8,81,92,25,96 and random numbers for services of customers are 10,38,15,55,92, system starts at 10:00 Am and using Monte Carlo simulation for the queuing system with the help of table given below: Find [5]

- (i) Mean queue length.
 (ii) Mean inter arrival time of a customer
 (iii) Mean service time of a customer.
 (iv) Mean idle time of server.
 (v) Mean time that a customer spends in the system

Inter-arrival time (min)	Probability	Service time (min)	Probability
5	0.15	7	0.15
6	0.35	10	0.35
7	0.40	9	0.30
8	0.10	15	0.20

SECTION "E"
 [2Q. × 2= 4 marks]

9. Show that the intersection of two convex sets is also a convex set.
 10. Define convex hull.

