

**MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL**

Paper Code : OEC-IT701A Operations Research

Time Allotted : 3 Hours

Full Marks :70

The Figures in the margin indicate full marks.

Candidate are required to give their answers in their own words as far as practicable

**Group-A (Very Short Answer Type Question)**

1. Answer any ten of the following :

[1 × 10 = 10]

- (i) What is Zero-sum game?
- (ii) If the arrival and departure rates in a M/M/1 queue are 1/2 per minute and 2/3 per minute respectively, find the average waiting time of a customer in the queue.
- (iii) When can you use graphical method of LLP?
- (iv) What is balanced transportation problem?
- (v) The objectives of network analysis is to \_\_\_\_\_.
- (vi) If  $D=18000$ , holding cost=Rs.1.20, set-up cost=Rs.400,  $EOQ =$  \_\_\_\_\_.
- (vii) Name two methods of finding an initial basic feasible solution to a transportation problem.
- (viii) What is a critical path?
- (ix) What is Lead Time?
- (x) What is payoff in game theory?
- (xi) If the primal problem has 2 constraints and 3 variables, then the number of constraints in the dual problem is \_\_\_\_\_.
- (xii) What are the similarity between assignment problem and transportation problem?

**Group-B (Short Answer Type Question)**

Answer any three of the following

[5 × 3 = 15]

- 2. Prove that intersection of two convex sets is also a convex set. [5]
- 3. Find the optimal assignment for the assignment problem with the given cost matrix. [5]

	$M_1$	$M_2$	$M_3$	$M_4$
$J_1$	10	12	19	11
$J_2$	5	10	7	8
$J_3$	12	14	13	11
$J_4$	8	15	11	9

Mr. X requires at least 10, 12 and 12 units of chemicals A, B and C for his garden. One jar of liquid product contains 5, 2 and 1 units of A, B, C respectively. A dry product contains 1, 2 and 4 units of A, B, C per carton. If the liquid product sells for Rs. 3 per jar and the dry product sells for Rs. 2 per carton, pose a LPP to show how many of each should be purchase to minimize the cost and to meet the requirements.

[5]

Use North-West Corner Method to find an initial basic feasible solution to the transportation problem

[5]

	$D_1$	$D_2$	$D_3$	$D_4$	$a_i$
$S_1$	19	30	50	10	7
$S_2$	70	30	40	60	9
$S_3$	40	8	70	20	18
$b_j$	5	8	7	14	

Food X contains 6 units of vitamin A per gram and 7 units of vitamin B per gram and cost 12 paise per gram. Food Y contains 8 units of vitamin A per gram and 12 units of vitamin B per gram and cost 20 paise per gram. The daily minimum requirement of vitamin A and B are 100 units and 120 units respectively. Find the minimum cost of product mix. (Formulate the problem).

[5]

**Group-C (Long Answer Type Question)**  
Answer any three of the following

[15 × 3 = 45]

(a) Find the optimal assignment for the assignment problem with the given cost matrix.

[7]

	$M_1$	$M_2$	$M_3$	$M_4$
$J_1$	1	4	6	3
$J_2$	9	7	10	9
$J_3$	4	5	11	7
$J_4$	8	7	8	5

Identical products are produced in three factories and sent to four warehouses for delivery to the customers. The cost of transportation and capacities are given by the cost matrix as

[4+4]

	$W_1$	$W_2$	$W_3$	$W_4$	$a_i$
$O_1$	3	8	7	4	30
$O_2$	5	2	9	5	50
$O_3$	4	3	6	2	80
$b_j$	20	60	55	40	

- Find an optimal schedule of delivery for minimization of cost of transportation.
- Do you anticipate any alternative optimum solution for the problem? How can the same be identified?

8. A small maintenance project consists of the following jobs whose precedence relationship is given below:

[4+3+3+2+3]

Activities	Estimated Duration (weeks)		
	Optimistic	Most Likely	Pessimistic
1 - 2	1	1	7
1 - 3	1	4	7
1 - 4	2	2	8
2 - 5	1	1	1
3 - 5	2	5	14
4 - 5	2	5	8
5 - 6	3	6	15

- Draw the project work.
- Find the expected duration and variance of each activity.
- Calculate the variance and standard deviations of project length. What is the probability that the project will be completed:
  - 4 weeks earlier than expected?
  - not more than 4 weeks later than expected?
- If the project due date is 19 weeks, what is the probability of meeting the due date? [Given that  $\phi(1.33) = 0.4082$  and  $\Phi(0.666) = 0.2514$ ].

9. (a) Prove that Dual of dual is primal.

[7]

(b) Solve the LPP using artificial variables

[8]

$$\begin{aligned}
 &\text{Minimize } z = -3x_1 + 2x_2 \\
 &\text{subject to} \\
 &\quad x_1 - 4x_2 \leq -14 \\
 &\quad -3x_1 + 2x_2 \leq 6 \\
 &\quad \text{and } x_1, x_2 \geq 0
 \end{aligned}$$

10. (a) Solve the transportation problem by VAM

[8]

	$W_1$	$W_2$	$W_3$	$a_i$
1	8	7	3	60
2	3	8	9	70
3	11	3	5	80
$b_j$	50	80	80	

Also verify whether the solution obtained by VAM is optimal or not? Find optimal solution, if the above solution is not optimal.

- (b) A travelling salesman has to visit 5 cities. He wishes to start from a particular city, visit each city once and then return to his starting point. Cost of going from one city to another is shown below. You are required to find the least cost route. [7]

	A	B	C	D	E
A	8	4	2	6	1
B	0	9	5	5	4
C	3	8	9	2	6
D	4	3	1	0	3
E	9	5	8	9	5

17. (a) Five men are available to do five different jobs. From past records, the time (in hours) that each man takes to do each job is known and is given in the following tables: [7]

	I	II	III	IV	V
A	8	4	2	6	1
B	0	9	5	5	4
C	3	8	9	2	6
D	4	3	1	0	3
E	9	5	8	9	5

Find out how men should be assigned the jobs in way that will minimize the total time taken.

- (b) Obtain the initial B.F.S. to the following transportation problem by Vogel's approximation method. [8]

	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	D <sub>4</sub>	D <sub>5</sub>	a <sub>i</sub>
O <sub>1</sub>	10	12	19	11	11	14
O <sub>2</sub>	5	10	7	8	8	9
O <sub>3</sub>	12	14	13	11	11	17
b <sub>j</sub>	8	3	8	13	8	

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