

Time: 3 Hours

- N.B. 1. All questions are compulsory.  
2. Figures to the right indicate full marks.  
3. Use of non-programmable calculator is allowed.  
4. Graph papers will be provided on request.

Q.1

- a. Choose correct answer for the following (ANY FIVE) :- (20)
- In Linear Programming Problem (L.P.P), constraints can be represented by- (10)
    - equalities
    - inequalities
    - ratios
    - both a and b
  - Graphical method can be applied to solve LPP when there are only ----- variables.
    - one
    - more than three
    - two
    - three
  - In Simplex method of solving LPP, a minimization problem can be converted into a maximization problem by changing the sign of coefficients in the-
    - constraints
    - objective function
    - both a and b
    - none of the above
  - In transportation problem, the preferred method of obtaining either optimal or very close to optimal solution is-
    - North-west corner rule
    - Least cost method
    - Vogel's approximation method
    - Simplex method
  - If there are  $n$  workers and  $n$  jobs there would be-
    - $n!$  Solutions
    - $(n-1)!$  solutions
    - $(n!)^n$  solutions
    - $n$  solutions
  - The Penalty in Vogel's Approximation Method represents difference between \_\_\_\_\_ cost of respective row / column.
    - largest and next largest
    - largest and smallest
    - smallest and next smallest
    - none of the above
  - The purpose of a dummy row or column in an assignment problem is to -
    - obtain balance between total activities
    - prevent a solution from becoming degenerate
    - provide a means of representing a dummy problem
    - none of the above

- b. Answer the following in one/ two sentences (ANY FIVE) : (10)
- Define Slack variable with reference to LPP .
  - What are the components of LPP?
  - State a necessary and sufficient condition for a feasible solution to the transportation problem.
  - A typical transportation problem may ask the question "How many of X should be shipped to destination E from source A?" Is the statement true? Correct if necessary.
  - In an assignment problem, the costs for a dummy row will be equal to the lowest cost of the column for each respective cell in that row. Is the statement true? Correct if necessary.
  - Define total elapsed time in sequencing problem for  $n$  jobs on 2 machines.
  - Give one example of sequencing problem in your daily life.

- Q.2 Attempt any TWO sub-questions: (20)**
- a. i. Write general mathematical model of a linear programming problem. State any two limitations of LPP? (06)**
- ii. A person requires 10, 12 and 12 units of chemicals A, B and C respectively for his garden. A liquid product contains 5, 2 and 1 units of A, B and C respectively per jar. A dry product contains 1, 2 and 4 units of A, B and C per carton. The liquid product sells for ₹ 3 per jar and the dry product sells for ₹ 2 per carton. Formulate this LPP to minimize the cost and meet the requirements. (04)**
- b. i. Define the following terms for a L.P.P. - (04)**
- 1) Feasible solution
  - 2) Basic feasible solution
  - 3) Optimum Basic feasible solution
  - 4) Unbounded solution.
- ii. Solve the following LPP graphically- (06)**
- Maximize  $Z = 50x + 30y$
- Subject to the constraints:
- $$2x + y \geq 18$$
- $$x + y \geq 12$$
- $$3x + 2y \leq 36$$
- $$x \geq 0, y \geq 0$$
- c. i. Discuss in brief 'Duality' in linear programming. (03)**
- ii. For the following table, check whether the solution is optimal. If not, obtain the optimal solution. (07)**

		$c_j$	4	3	0	0	0	0	
Basic variables	Basic variables	Basic variables value	$x_1$	$x_2$	$s_1$	$s_2$	$s_3$	$s_4$	Min. ratio
$C_B$		$X_B$							
0	$s_1$	200	0	1	1	0	-2	0	
0	$s_2$	400	0	1	0	1	-1	0	
4	$x_1$	400	1	0	0	0	1	0	
0	$s_4$	700	0	1	0	0	0	1	
		$z_j$	4	0	0	0	4	0	

Q.3

Attempt any TWO sub-questions:

- a. i. What is transportation problem? Describe the transportation problem with 4 origins and 5 destinations. (20)
- ii. Find the initial basic feasible solution by – (04)
- (1) the North-West corner method (06)
- (2) Matrix minima method (least cost method) of the transportation problem whose cost matrix, requirement and availability are given in the following table-

Source	Destination				Availability
	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	D <sub>4</sub>	
O <sub>1</sub>	9	7	11	10	35
O <sub>2</sub>	10	13	14	8	50
O <sub>3</sub>	15	10	17	6	40
Requirement	45	20	30	30	125

- b. There are three sources or origins, which store a given product. These sources supply these products to four dealers. The capacities of the sources and the demands are as given below- (10)

$$S_1 = 150, S_2 = 40, S_3 = 80$$

$$D_1 = 90, D_2 = 70, D_3 = 50, D_4 = 60$$

The cost of transporting the product from various sources to various dealers is shown in the table below.

Source	Destination			
	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	D <sub>4</sub>
S <sub>1</sub>	27	23	31	69
S <sub>2</sub>	10	45	40	32
S <sub>3</sub>	30	54	35	57

Find out the optimum solution for transporting the products at a minimum cost.

- c. i. What is an unbalanced transportation problem? Explain how to transform an unbalanced transportation problem into a balanced transportation problem (03)
- ii. Solve the following transportation problem- (07)

Suppliers	Consumers			Availability
	A	B	C	
I	6	8	4	14
II	4	9	8	12
III	1	2	6	5
Requirement	6	10	15	

Use Vogel's Approximation method to find an initial basic feasible solution and prove it to be optimal.

QP CODE : 24196

- Q.4**
- Attempt any TWO sub-questions:** (20)
- a. i. What is an assignment problem? Give two examples. (04)
- ii. A construction company has requested bids for sub contract on five different projects. Five companies have responded, their bids are represented below : (06)

Bidders	Bid amounts ('000 Rs.)				
	I	II	III	IV	V
1	41	72	39	52	25
2	22	29	49	65	81
3	27	39	60	51	40
4	45	50	48	52	37
5	29	40	45	26	30

Determine the minimum cost assignment of sub contracts to bidders, assuming that each bidder can receive only one contract.

- b. i. What is sequencing problem? State any two underlying assumptions of it. (04)
- ii. A company has four machines, which are to be used for three jobs. Each job can be assigned to one and only one machine. The cost of each job on each machine is given in the following table. (06)

Jobs	Machines			
	W	X	Y	Z
A	18	24	28	32
B	8	13	17	18
C	10	15	19	22

What are the job-assignment pairs, which shall minimize the cost?

- c. Find the sequence that minimizes the total elapsed time required to complete the following tasks. Each job is processed in the order ABC. Find the total elapsed time. Also obtain idle time on three machines. (10)

Machines	1	2	3	4	5	6	7
A	3	8	7	4	9	8	7
B	4	3	2	5	1	4	3
C	6	7	5	11	5	6	12

- Q.5**
- Attempt any TWO sub-questions:** (20)

- a. i. What is the use of minimum ratio test in selecting a key row in simplex table? State the condition that must exist in a simplex table to establish the existence of an alternate solution. (04)
- ii. Obtain the dual problem of the following L.P.P. (06)

$$\text{Maximize } Z = x_1 - x_2 + 3x_3$$

Subject to the constraints:

$$x_1 + x_2 + x_3 \leq 10$$

$$2x_1 - x_3 \leq 2$$

$$2x_1 - 2x_2 + 3x_3 \leq 6$$

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

- b. i. What is Transportation problem? Write a general mathematical model of Transportation Problem. (05)

- ii. Determine an initial basic feasible solution to the following transportation problem by using North-West Corner method. (05)

Source	Destination				Supply
	D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	D <sub>4</sub>	
S <sub>1</sub>	1	2	1	4	30
S <sub>2</sub>	3	3	2	1	50
S <sub>3</sub>	4	2	5	9	20
Demand	20	40	30	10	

- c. i Explain the Hungarian method to solve an assignment problem. (05)

- ii We have seven jobs each of which has to go through the machine M<sub>1</sub> and machine M<sub>2</sub> in the order M<sub>1</sub> M<sub>2</sub>. Processing times (in hours) are given as: (05)

Machines	1	2	3	4	5	6	7
M <sub>1</sub>	3	12	15	6	10	11	9
M <sub>2</sub>	8	10	10	6	12	1	3

Determine the sequence of these jobs that will minimize the total elapsed time. Find the total elapsed time.

\*\*\*\*\*