No. of Printed Pages : **4**

Sl. No.

BE10-R4 : APPLIED OPERATIONS RESEARCH

NOTE :

1. **Answer question 1 and any FOUR from questions 2 to 7.**
2. **Parts of the same question should be answered together and in the same sequence.**

Total Time : 3 Hours **Total Marks : 100**

1. (a) Solve the following linear programming problem graphically :

Maximize $Z = x_1 + 3x_2$,

subject to

$$4x_1 + 2x_2 \leq 80$$
$$2x_1 + 5x_2 \leq 180,$$
$$x_1,\ x_2 \geq 0$$

(b) Obtain the dual of the following linear programming problem :

Maximize $Z = 3x_1 + 2x_2$,

subject to

$$x_1 + 3x_2 \geqslant 1,$$
$$x_1 + x2 \leq 7,$$
$$x_1 + 2x_2 \leq 10,$$
$$2x_2 \leq 3,\ x_1,\ x_2 \geqslant 0.$$

(c) A Company is planning to produce at least 2000 widget on three machines. The minimum lot size on any machine is 500 widget. The following table gives the pertinent data of the situation.

Machine	Set up cost	Production cost/Unit	Capacity (Units)
1	300	2	600
2	100	10	800
3	200	5	1200

Formulate the problem as an integer linear programming problem.

(d) Distinguish between PERT and CPM. What is a critical path ?

(e) Use Vogel's approximation method to find an initial basic feasible solution of the following transportation problem :

	A	B	C	Supply
P	6	4	1	50
Q	3	8	7	40
R	4	4	2	60
Demand	20	95	35	150

(f) A particular item has demand of 9000 units/year. The cost of procurement is Rs. 100 and the holding cost unit is Rs. 2.40/year. The replacement is instantaneous and no shortages are allowed. Determine (i) the economic lot size, (ii) the time between orders, (iii) the number of orders per year.

(g) A super market has two girls ringing up sales at the counters. If the service time for each customer is exponential with mean 4 minutes, and if people arrive in a Poisson fashion at the counter at the rate of 10 an hour find (i) the steady-state probability of having to wait for service and (ii) the steady-state expected percentage of idle time for each girl ?

(7x4)

2. (a) Use dual simplex method to solve the following linear programming problem :

$$\text{Minimize. } Z = 4x_1 + 2x_2$$

subject to

$$x_1 + 2x_2 \geq 2,$$
$$3x_1 + x_2 \geq 3,$$
$$4x_1 + 3x_2 \geq 6,$$
$$x_1, x_2 \geq 0.$$

(b) A salesman is planning to tour cities B, C, D and E, starting from his home city A. The intercity distances are shown in the following table :

City	A	B	C	D	E
A	0	103	188	136	38
B	103	0	262	176	52
C	187	262	0	85	275
D	136	176	85	0	162
E	38	52	275	162	0

How should he plan his tour so that (i) he visits each of the cities only once, and (ii) travels the minimum distance ?

(9+9)

3. (a) Solve the following by big M method :

$$\text{Maximize } Z = 3x_1 + 2x_2,$$

subject to

$$2x_1 + x_2 \leq 2,$$
$$3x_1 + 4x_2 \geq 12, x_1 \text{ and } x_2 \geq 0.$$

(b) Show graphically that the following integer linear programming has no feasible solution, and then verify the result using Branch and Bound.

$$\text{Maximize } Z = 2x_1 + x_2,$$

subject to

$$10x_1 + 10x_2 \leq 9,$$
$$10x_1 + 5x_2 \geq 1, x_1, x_2 \geq 0 \text{ and integer.}$$

(9+9)

4. (a) A project has the following time schedule :

Activity	A	B	C	D	E	F	G
Preceding Activities	-	-	-	A, B	A, B	C, D, E	C, D, E
Duration (in days)	4	7	6	5	7	6	5

(i) Draw the network and find the project completion time.
(ii) Calculate total float for each activity.
(iii) Critical path and its duration.

(b) Given the following data regarding the processing times of some jobs on three machines M1-M2-M3. Determine the sequence that minimizes the total elapsed time (T) required to complete the following jobs. Also evaluate T, and idle time of M2 and M3.

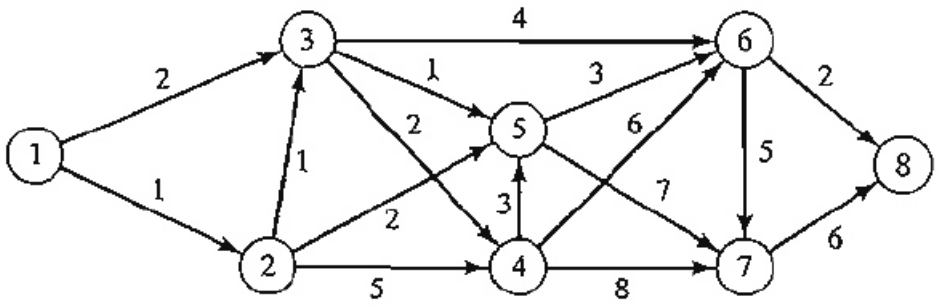
	A	B	C	D	E	F	G
M1	30	80	70	40	90	80	70
M2	40	30	20	50	10	40	30
M3	60	70	50	110	50	60	120

(9+9)

5. (a) The network in following figure gives the distances in miles between pairs of cities 1, 2,…, and 8. Use Dijkstra's algorithm to find the shortest route between the following cities :

(i) Cities 1 and 8,

(ii) Cities 1 and 6.



(b) An IT lab has four employees with four jobs to be performed. The time in hours each employee can take to perform each job is given in the following matrix :

	Employees			
Jobs ↓	I	II	III	IV
A	15	11	13	15
B	17	12	12	13
C	14	15	10	14
D	16	13	11	17

How should the jobs be allocated, one per employee, so as to minimize the total man hours ? Also discuss the method used. **(9+9)**

6. (a) Transform the following pay-off matrix of a two-person zero-sum game into an equivalent linear programming problem and then solve it using simplex method.

		Player B		
		1	2	3
Player A	1	1	−1	3
	2	3	5	−3
	3	6	2	−2

(b) A showroom has the capacity of 30 customers. It is found that customers arrive in a Poisson fashion throughout the day with mean arrival rate of 10 per hour and service time for each customer is exponential with mean 15 minutes. If N(t) be the number of customers in the bank at any instant, find (i) an independent equation between P(N(t)=20), P(N(t)=21) and P(N(t)=22) during non-steady state, (ii) an independent equation between P(N(t)=10), P(N(t)=11) and P(N(t)=12) during steady state and (iii) average number of customers in the showroom during steady state. **(9+9)**

7. (a) Perform two complete iterations of steepest descent method to find the point of minimum value of $f(x_1, x_2) = -8x_1 - 8x_2 + 2x_1^2 + 2x_1x_2 + x_2^2$ starting from the point (0, 0).

(b) For the data shown in the following table, determine approximately the economic order quantities when the total value of average inventory level of three products is Rs. 1000.

	Item 1	Item 2	Item 3
Holding Cost (Rs.)/unit/year	20	20	20
Setup cost (Rs.)	50	40	60
Purchasing cost per unit (Rs.)	6	7	5
Yearly demand	10000	12000	7500

(9+9)

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