

**GUJARAT TECHNOLOGICAL UNIVERSITY****BE- SEMESTER-V (NEW) EXAMINATION – WINTER 2020****Subject Code:3151910****Date:05/02/2021****Subject Name:Operation Research****Time:10:30 AM TO 12:30 PM****Total Marks: 56****Instructions:**

1. Attempt any FOUR questions out of EIGHT questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1** (a) State various phases of Operations Research problem. **03**  
 (b) Briefly explain the characteristics of Operations Research. **04**  
 (c) A paper mill produces paper for books as well as for magazines. Each kg of paper for books requires 2 kg of material A and 3 kg of material B. for magazines, the proportion is 2 kg of A and 2 kg of B for each kg of paper. The mill need 15000 kg paper for books and 6000 kg for magazines. Materials A and B are available as 3 and 5 lakhs kg respectively. Requirements of books is twice that for magazines. Selling price per book paper is Rs. 14 per kg and for magazines it is Rs. 10 per kg. cost of material A is Rs. 2 per kg and that for material B is Rs. 2.5 per kg. Formulate LP model for paper mill to maximize the total profit. **07**

- Q.2** (a) Write at least five application areas of Linear Programming. **03**  
 (b) Discuss basic assumptions in Linear Programming. **04**  
 (c) Solve the following LP problems using Simplex Method. **07**

Maximise  $Z = 10x + 15y + 20z$   
 S.T.  
 $10x + 5y + 2z \leq 2,700$   
 $5x + 10y + 4z \leq 2,200$   
 $x + y + 2z \leq 500$  and  
 All  $x, y$  and  $z$  are  $\geq 0$

- Q.3** (a) Explain the following terms: **03**  
     a. Shadow price  
     b. Opportunity cost  
 (b) Briefly explain unbalanced assignment problem. **04**  
 (c) A company manufacturing air coolers has two plants located at Mumbai and Kolkata with a capacity of 200 units and 100 units per week respectively. The company supplies the air cooler to its four show rooms located at Ranchi, Delhi, Lucknow and Kanpur which have a maximum demand of 75, 100, 100, and 30 units respectively. Due to the differences in raw material cost and transportation cost, the profit per unit in rupees differs which is given below. **07**

	Ranchi	Delhi	Lucknow	Kanpur
Mumbai	90	90	100	110
Kolkata	50	70	130	85

Solve the transportation problem to maximize the profit.

- Q.4** (a) Give mathematical model for transportation problem. **03**  
 (b) Define the term Decision theory. Describe decision models based on the criterion of degree of certainty. **04**

- (c) Five wagons are available at stations 1, 2, 3, 4, and 5. These are required at five stations I, II, III, IV and V. The mileage between various stations are given by the table below. How should the wagons be transported so as to minimize total mileage covered? **07**

	I	II	III	IV	V
1	10	5	9	18	11
2	13	9	6	12	14
3	3	2	4	4	5
4	18	9	12	17	15
5	11	6	14	19	10

- Q.5 (a)** Explain the queuing model as indicated by the following notations. **03**

M/D/1 : FCFS/ $\infty/\infty$

- (b) The following matrix gives the payoff of different strategies (alternatives) A, B, and C against conditions (events) W, X, Y and Z. Identify the decision taken under the following approaches: **04**
- Regret,
  - Hurwicz criterion. The decision maker's degree of optimism ( $\alpha$ ) being 0.7.

	Events			
	W	X	Y	Z
	Rs.	Rs.	Rs.	Rs.
A	4000	-100	6000	18000
B	20000	5000	400	0
C	20000	15000	-2000	1000

- (c) A mechanic is to be recruited to repair scooters that breakdown at an average rate of 6 per hour. The breakdowns follow a Poisson distribution. Non-productive time of a scooter costs Rs. 40 per hour. Mechanics A and B have been interviewed for the purpose. Mechanic A charges Rs. 20 per hour, and services scooters at the rate of 8 per hour. Mechanic B charges Rs. 28 per hour, and services 12 scooters per hour, on an average. Which one of the two should be recruited and why? Assume an 8 hours of work each day. **07**

- Q.6 (a)** What is replacement? Explain by means real world examples. **03**

- (b) Differentiate between PERT and CPM. **04**

- (c) The maintenance cost and resale value per year of a machine whose purchase price is Rs. 7000/- is given below: **07**

Year	1	2	3	4	5	6	7	8
Maintenance cost in Rs.	900	1200	1600	2100	2800	3700	4700	5900
Resale value in Rs.	4000	2000	1200	600	500	400	400	400

When should the machine be replaced?

- Q.7 (a)** Define following: **03**

- Saddle Point
- Pure Strategy
- Mixed Strategy

- (b) Discuss the rules of network construction **04**

- (c) A and B play a game in which each has three coins: 5 paise, 10 paise, and 20 paise coin. Each player selects a coin without the knowledge of the other's choice. If the sum of the coins is an odd amount, A wins B's coin, and if the sum is even, B wins A's coin. Find the best strategy for each player and the value of the game. **07**

- Q.8 (a)** Briefly explain Decision Tree **03**

(b) Discuss all four types of Floats.

(c) There are seven activities in a project and the time estimates are as follows:

Activity	Immediate Predecessor	Optimistic Time	Most Likely Time	Pessimistic Time
A	—	2	6	10
B	—	4	6	12
C	A	2	3	4
D	A	2	4	6
E	B, D	3	6	9
F	B, C, D	6	10	14
G	F	1	3	5

Draw activity on node network for the project. Calculate expected project duration and variance for each activity.

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**GUJARAT TECHNOLOGICAL UNIVERSITY****BE - SEMESTER-V (NEW) EXAMINATION – WINTER 2021****Subject Code:3151910****Date:24/12/2021****Subject Name:Operation Research****Time:02:30 PM TO 05:00 PM****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

		<b>MARKS</b>
<b>Q.1</b>	(a) Illustrate graphically for Linear Programming Problem; (a) No-feasible solution (b) Unbounded solution.	<b>03</b>
	(b) Discuss various areas for the application of operations research techniques.	<b>04</b>
	(c) Mention different phases of operations research and explain their significance for decision making.	<b>07</b>
<b>Q.2</b>	(a) What are the assumptions in LPP?	<b>03</b>
	(b) Solve following problem with graphical method. Maximize $Z = 3X_1 + 9X_2$ Subject to $X_1 + 4X_2 \leq 8$ , $X_1 + 2X_2 \leq 4$ and $X_1, X_2 \geq 0$	<b>04</b>
	(c) Using Simplex method of Linear programming technique, solve the following problem. Maximize $Z = 5x_1 + 4x_2$ Subject to $x_1 - 2x_2 \leq 1$ , $x_1 + 2x_2 \geq 3$ and $x_1, x_2 \geq 0$ .	<b>07</b>

**OR**

	(c) Solve the following problem using Big M method Maximize $Z = 4x + 5y$ Subjects to $2x + 3y \leq 6$ , $3x + y \geq 3$ and $x, y \geq 0$ .	<b>07</b>
<b>Q.3</b>	(a) Differentiate CPM & PERT.	<b>03</b>
	(b) Define event, activity, preceder activity, successor activity, dummy activity with respect to CPM/PERT.	<b>04</b>
	(c) Tasks A to I constitutes a project in which the precedence relationships are $A < D$ ; $A < E$ ; $B < F$ ; $D < F$ ; $C < G$ ; $C < H$ , $F < I$ ; $G < I$ .	<b>07</b>

Time in day for each task is as follows:

Task	A	B	C	D	E	F	G	H	I
Time	8	10	8	10	16	17	18	14	9

Draw the network to represent the project and find out total float of each activity and identify critical path.

**OR**

- Q.3** (a) What is degeneracy in transportation problem? **03**  
 (b) What is 'dominance rule' in game theory? How can a 'two person-zero sum game' problem be converted into LP problem? **04**  
 (c) Solve the following transportation problem for maximum profit. Use vogel's approximation method to find out initial feasible solution. **07**

		Market (Per unit profit in Rs.)			
		A	B	C	D
Warehouse	X	12	18	6	25
	Y	8	7	10	18
	Z	14	3	11	20

Availability in	Demand in the
X = 200 units	A = 180 units
Y = 500 units	B = 320 units
Z = 300 units	C = 100 units
	D = 400 units

- Q.4** (a) Discuss group replacement policy with suitable example. **03**  
 (b) What do you understand by 'zero-sum' in the context of game theory? **04**  
 Explain the meaning following terms used in game theory;  
 i. Saddle Point  
 ii. Pure Strategy  
 iii. Mixed Strategy  
 (c) A machine cost Rs 500. Operation and maintenance cost are zero for the first year and increases by Rs. 100 every year. If money is worth 5% every year, determine the best age at which the machine should be replaced. The resale value of the machine is negligibly small. What is the weighted average cost of owning and operating the machine? **07**

**OR**

- Q.4** (a) Discuss various costs involved in an Inventory model. **03**  
 (b) Discuss the difference between decision-making under certainty, under uncertainty and under risk. **04**  
 (c) The following is the pay-off matrix between player X and player Y. Find the optimal strategies, their frequencies and the value of the game. Use rule of dominance and oddment in calculations. **07**

PLAYER X	PLAYER Y			
	A	B	C	D
I	0.25	0.20	0.14	0.30
II	0.27	0.16	0.12	0.14
III	0.35	0.08	0.15	0.19
IV	-	0.08	0.13	0.00

- Q.5** (a) What are various performance measures of a queuing system? Discuss in brief. **03**  
 (b) What is transshipment problem? Explain how it can be formulated and solved as a transportation problem? **04**  
 (c) A self-service store employs one cashier at its counter, Nine customers arrive on an average every 5 minutes while the cashier can serve 10 customers in 5 minutes. Assuming Poisson distribution for arrival rate and exponential distribution for service rate, find **07**  
 i. Average number of customers in the system  
 ii. Average number of customers in queue

- iii. Average time a customer spends in the system
- iv. Average time a customer waits before being served.

**OR**

- Q.5**
- (a) How to tackle the non-square matrix in the assignment problem? Explain with suitable example. **03**
  - (b) Is it possible to solve assignment problem using transportation technique? Explain with reason. **04**
  - (c)
    - 1. Define the following terms: balking, reneging and jockeying. **07**
    - 2. Explain in brief characteristic of queuing theory. What is traffic intensity? If traffic intensity of a system is given to be 0.76, what percent of time the system would be idle?

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**GUJARAT TECHNOLOGICAL UNIVERSITY****BE - SEMESTER-V (NEW) EXAMINATION – SUMMER 2021****Subject Code:3151910****Date:20/09/2021****Subject Name:Operation Research****Time:10:30 AM TO 01:00 PM****Total Marks:70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

- Q.1**
- (a) Explain limitations of operation research. **3**
- (b) Explain advantages and limitations of linear programming. **4**
- (c) Explain stepwise procedure to solve linear programming problem with graphical method. **7**
- Q.2**
- (a) Explain different phases of Operation research. **3**
- (b) Explain assumptions (properties) of linear programming. **4**
- (c) Solve the following problem by simplex method:  
 Maximize  $Z = 3x_1 + 2x_2$   
 Subject to constraints  
 $2x_1 + x_2 \leq 5$  **7**  
 $x_1 + x_2 \leq 3$   
 and  $x_1, x_2 \geq 0$ .

**OR**

- (c) Discuss various application areas of OR. **7**
- Q.3**
- (a) What is degeneracy in transportation problem? **3**
- (b) The following table shows costs of transportation per unit product from plants to cities. Find the Initial basic feasible solution using Voggle's approximation method.

From/To	D	E	F	Supply
A	4	5	1	40
B	3	4	3	60
C	6	2	8	70
Demand	70	40	60	

**4**

- (c) The captain of a cricket team has to allot five middle order batting positions to 5 batsmen available for selection. The average runs scored by each batsman at these positions are summarized in a table below. Using Assignment model, determine the assignment of batsmen to positions which would give maximum runs in favor of team.

Batsman	Batting positions				
	I	II	III	IV	V
A	40	46	48	36	48
B	48	32	36	29	44
C	49	35	41	38	45
D	30	46	49	44	44
E	37	41	48	43	47

**7**

**OR**

- Q.3** (a) Explain: Procedure for Group Replacement Theory 3  
(b) Explain: (1) Saddle point (b) Limitations of a Game theory. 4  
(c) Explain steps for decision theory approach. 7

- Q.4** (a) Define the following terms relating the customer's behavior in Queue. 3  
(A) Balking (B) Jockeying (C) Reneging  
(b) Explain Kendall's notation for queuing system. 4  
(c) In a bank counter, customers arrive at a rate of 30 customers per day. Assuming that the inter arrival time follows an exponential distribution and service time distribution is also exponential with an average of 36 minutes. Calculate: 7  
Expected queue size  
Probability that the queue size exceeds 10

**OR**

- Q.4** (a) What is "Strategy"? Explain the difference between pure strategy and mixed Strategy? 3  
(b) Explain N-W corner method of transportation model 4  
(c) Explain the steps of a Travelling Salesman Problem. 7
- Q.5** (a) What is replacement? Describe some important replacement situations. 3  
(b) Explain forward and backward planning in CPM and PERT. 4  
(c) A person is planning to purchase a car. A new car is costing rupees 3 lacs. The resale value of the car at the end of the year is 85 % of the previous year. Maintenance and repair cost during the first year are rupees 10000 and they increase by 15 % every year. The minimum resale value of the car can be rupees 75000. (a) When should the car be replaced to minimize average annual cost? (b) If interest rate of 12 % is assumed, calculate the average cost at the end of 10 years. 7

**OR**

- Q.5** (a) Mention any two limitations of critical path. 3  
(b) Explain D.R. Fulkerson's Rule for Network diagram. 4  
(c) Consider the following given data and based on that find out critical path for the given project:

Activity	Time (days)
1-2	6
1-3	9
2-4	3
3-4	4
3-5	8
2-6	12
4-6	7
5-6	1

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**GUJARAT TECHNOLOGICAL UNIVERSITY****BE - SEMESTER-V(NEW) EXAMINATION – SUMMER 2022****Subject Code:3151910****Date:17/06/2022****Subject Name:Operation Research****Time:02:30 PM TO 05:00 PM****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

**MARKS**

- Q.1**
- (a) Summarize applications of operation research. **03**
- (b) Explain significance of positive, zero and negative opportunity cost with respect to transportation problem. **04**
- (c) Solve graphically **07**
- Maximize  $Z = 10x_1 + 15x_2$   
 Subject to,  $2x_1 + x_2 \leq 26$   
 $2x_1 + 4x_2 \leq 56$   
 $x_1 - x_2 \geq -5$   
 $x_1, x_2 \geq 0$
- Q.2**
- (a) Define slack and surplus variable with respect to linear programming problem **03**
- (b) A person wants to invest up to 500000 in fixed securities scheme. Broker recommends two bonds: Bond A yielding 8% and bond B yielding 10%. He decide to invest at most 100000 in bond A and at least 200000 in bond B. he also wants the amount invested in bond A to be at least equal to amount invested in bond B. Formulate the problem **04**
- (c) A simplex problem and its solution is given in table. **07**
- (i) Formulate dual to the given problem  
 (ii) Verify the objective function value for both the primal and dual using value given in table

Maximize  $Z = x_1 + 1/2 x_2$   
 Subjects to  $6x_1 + 2x_2 \geq 24$   
 $3x_1 + 2x_2 \geq 18$   
 $x_1 + 3x_2 \geq 12$  and  $x_1, x_2 \geq 0$

Basis	x1	x2	S1	S2	S3	A1	A2	A3	bi
x1	1	0	-1/3	1/3	0	1/3	-1/3	0	2
S3	0	0	7/6	-8/3	1	-7/6	8/3	-1	8
x2	1/2	1	1/2	-1	1	-1/2	1	0	6
cj	1	1/2	0	0	0	M	M	M	
solution	2	6	0	0	8	0	0	0	
$\Delta_j$	0	0	1/12	1/6	0	M-1/12	M-1/6	M	

**OR**

- (c) Solve the following LPP using Simplex method **07**
- Maximize:  $Z = 2x_1 + 4x_2$   
 Subject to  $2x_1 + x_2 \leq 18$   
 $3x_1 + 2x_2 \geq 30$   
 $x_1 + 2x_2 = 26$  and  
 $x_1, x_2 \geq 0$

- Q.3 (a)** How profit maximization problem can be solved in assignment technique? **03**
- (b)** Amul milk has three plant A, B & C with daily milk processing capacity (in Mega Liter) as 11, 6 & 5 and requirement at distribution center P, Q, R & S are 8, 4, 7 & 3 Mega liter respectively. Unit transportation cost is given in the table. Find the initial feasible solution using N-W corner method. **04**

Unit transportation cost (Rs. in 1000/ Mega Litre)				
	P	Q	R	S
A	2	5	3	8
B	4	1	6	4
C	7	5	8	2

- (c)** To repair four road of city five contractor bid the tender (amount in lakhs). **07**  
Using assignment techniques find...  
1 optimum cost of road repairing?  
2 Which contractor will be unable to get contract?

		Road			
		A	B	C	D
contractor	P	9	14	19	25
	Q	7	17	20	19
	R	9	18	21	18
	S	10	12	18	19
	T	10	15	21	16

**OR**

- Q.3 (a)** Explain degeneracy in transportation problem. **03**
- (b)** Is given solution of assignment problem is correct as per the criterion of travelling salesmen problem? If not, then modified it. **04**

	I	II	III	IV	V
I	M	5	15	30	0
II	20	M	0	30	0
III	20	15	M	0	15
IV	40	0	5	M	5
V	0	10	0	35	M

- (c)** Find the optimum solution for the following transportation table. **07**

	W1	W2	W3	W4	Capacity
F1	19	30	50	10	7
F2	70	30	40	60	9
F3	40	8	70	20	18
Requirement	5	8	7	14	

- Q.4 (a)** Explain 'zero-sum' in the context of game theory. **03**

- (b) Bikes arrives at fuel pump in poisons fashion with an average of 9 bikes per 5 minutes. service boy can refuel 10 bikes in 5 minutes. Find... **04**
1. Average number of bikes in a system. And in queue.
  2. Average time a bike spends in system.
  3. Average time a bike waits before being served.
- (c) Running cost and resale value of bike whose purchase price is ₹ 60,000, given in the table, find the age of replacement. **07**

Year	1	2	3	4	5	6	7
Resale value	30000	15000	7500	3750	2000	2000	2000
Running cost	10000	12000	14000	18000	23000	28000	34000

**OR**

- Q.4** (a) Define a) Balking b) Jockeying c) Reneging with respect to queueing **03**
- (b) Discuss group replacement policy with suitable example. **04**
- (c) In a game of matching coins with two players, player A wins ₹1 when there are two heads, wins nothing when there are two tails and loose ₹1/2 when one head and one tail. Determine the payoff matrix, strategies and value of game. **07**
- Q.5** (a) Explain predecessor, successor and dummy activity with diagram. **03**
- (b) Jyoti CNC introduce three model of CNC machine, which can lead to increase, neutral and decrease in sales. Sales department workout the payoff in terms of yearly net profit for each type of sales action as tabulated below. **04**

	Estimated net profit (In Crores)		
Machine types	Increase	Neutral	Decrease
Model 1	60	30	30
Model 2	30	40	30
Model 3	15	10	25

help to take decision using Maximax and Laplace criterion.

- (c) Draw a network corresponding to following tabular information and calculate early and latest start & finish time also determine critical path. **07**

Activity	1-2	1-3	2-6	3-4	3-5	4-6	5-6	5-7	6-7
Duration	4	6	8	7	4	6	5	19	10

**OR**

- Q.5** (a) Discuss the difference between decision-making under certainty, under uncertainty and under risk. **03**
- (b) Differentiate PERT and CPM **04**
- (c) Tasks A to I constitutes a project in which the precedence relationships are A < D; A < E; B < F; D < F; C < G; C < H, F < I; G < I. Time in day for each task is as follows: **07**

Task	A	B	C	D	E	F	G	H	I
Time	8	10	8	10	16	17	18	14	9

Draw the network to represent the project and find out total float of each activity and identify critical path

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