Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V EXAMINATION – SUMMER 2025

Subject Code:3151910 Date:26-05-2025

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)**	Discuss various applications of operation research.	**03**
	(b)	Illustrate graphically for Linear Programming Problem; (a) No-feasible solution (b) Unbounded solution.	**04**
	(c)	ABC Printing Company is facing a tight financial squeeze and is attempting to cut costs wherever possible. At present it has only one printing contract, and luckily, the book is selling well in both the hardcover and the paperback editions. It has just received a request to print more copies of this book in either the hardcover or the paperback form. The printing cost for the hardcover books is Rs 600 per 100 books while that for paperback is only Rs 500 per 100. Although the company is attempting to economize, it does not wish to lay off any employee. Therefore, it feels obliged to run its two printing presses - I and II, at least 80 and 60 hours per week, respectively. Press I can produce 100 hardcover books in 2 hours or 100 paperback books in 1 hour. Press II can produce 100 hardcover books in 1 hour or 100 paperbacks books in 2 hours. Determine how many books of each type should be printed in order to minimize costs.	**07**
Q.2	**(a)**	What are the assumptions in LPP?	**03**
	(b)	What is degeneracy in transportation problem?	**04**
	(c)	Solve the following problem using Big-M method.	**07**

Minimize $Z=2X1+5X2$

Subject to constraints $X_1+X_2 = 100$

$X_1 \leq 40$

$X_2 \geq 30$

Non-negative condition $X_1, X_2 \geq 0$

OR

(c) Solve the following LP problem graphically: **07**

Maximize $Z = -X_1+2X_2$

Subject to constraints $X_1-X_2 \leq -1$

$-0.5X_1+X_2 \leq 2$

$X_1, X_2 \geq 0$

Q.3 **(a)** What is 'dominance rule' in game theory? **03**

(b) Is it possible to solve assignment problem using transportation technique? Explain with reason **04**

(c) The following table provides all the necessary information on the availability of supply to each warehouse, the requirements of each market and the unit transportation cost (in Rs) from each warehouse to each market. **07**

Warehouse	Market				
	P	Q	R	S	Supply
A	6	3	5	4	22
B	5	9	2	7	15
C	5	7	8	6	8
Demand	7	12	17	9	45

The shipping clerk of the shipping agency has worked out the following schedule, based on his own experience: 12 units from A to Q, 1 unit from A to R, 9 units from A to S, 15 units from B to R, 7 units from C to P and 1 unit from C to R.

(a) Check and see if the clerk has the optimal schedule.

(b) Find the optimal schedule and minimum total transport cost.

(c) If clerk is approached by a carrier of route C to Q, Who offers to reduce his rate in the hope of getting some business, by how much should the rate be reduced before the clerk would offer him the business.

OR

Q.3 **(a)** Explain: Procedure for Group Replacement Theory **03**

(b) Briefly explain Decision Tree **04**

(c) Explain the steps of a Travelling Salesman Problem. **07**

Q.4 **(a)** Define the following terms relating the customer's behavior in Queue. **03**
(A)Balking (B) Jockeying (C) Reneging

(b) What is float? Discuss in brief (i) Total float (ii) Free Float. **04**

(c) Two breakfast food manufacturers KFG and MCZ are competing for an increased market share. The playoff matrix, shown in the following table, describes the increase in market share for KFG and decrease in market share of MCZ. **07**

KFG	MCZ			
	Give Coupons	Decrease Price	Maintain Present Strategy	Increase advertising
Give Coupons	2	-2	4	1
Decrease Price	6	1	12	3
Maintain Present Strategy	-3	2	0	6
Increase advertising	2	-3	7	1

Determine the optimal strategies for both the manufacturers and the value of game.

OR

Q.4 **(a)** Define following: **03**

a. Saddle Point

b. Pure Strategy

c. Mixed Strategy

(b) How profit maximization problem can be solved by assignment Problem? **04**

(c) An engineering company is offered a material handling equipment A. It is priced at Rs 60,000 including cost of installation. The cost for operation and maintenance are estimated to be Rs 10,000 for each of the fiveyear, increasing every year by Rs 3,000 in the sixth and subsequent years.The company expects a return of 10 per cent on all its investment. What is the optimal replacement period? **07**

Q.5 **(a)** Explain the following terms used in decision theory. **03**

EMV, EOL, EVPI.

(b) A warehouse has only one loading dock manned by a three person crew. Trucks arrive at the loading dock at an average rate 4 trucks per hour and the arrival rate is Poisson distributed. The loading of truck takes 10 minutes on an average and can be assumed to be exponentially distributed. The operating cost of a truck is Rs 20 per hour and the members of the loading crew are paid Rs. 6 each per hour. Would you advise the truck owner to add another crew of three persons? **04**

(c) The following table gives the activities in a construction project and also gives other relevant information **07**

Activity	Immediate Predecessor	Time		Direct Cost (Rs 'ooo))	
		Normal	Crash	Normal	Crash
A	-	4	3	60	90
B	-	6	4	150	250
C	-	2	1	38	60
D	A	5	3	150	250
E	C	2	2	100	100
F	A	7	5	115	175
G	D, B, E	4	2	100	240
				713	

Indirect costs vary as follows

Months :	15	14	13	12	11	10	9	8	7	6
Cost (Rs) :	600	500	400	250	175	100	75	50	35	25

(a) Draw the arrow diagram for the project.

(b) Determine the project duration that will result in minimum total project cost.

OR

Q.5 **(a)** What is replacement? Explain by real examples. **03**

(b) Discuss the rules network construction. **04**

(c) Explain steps for decision theory approach. **07**

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Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–V (NEW) EXAMINATION – SUMMER 2024

Subject Code:3151910 Date:29-05-2024

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)**	Illustrate graphically for Linear Programming Problem; (a) No-feasible solution (b) Unbounded solution	**03**
	(b)	A company makes two products (A and B) and both require processing on 2 machines. Product A takes 10 and 15 minutes on the two machines per unit and product B takes 22 and 18 minutes per unit on the two machines. Both the machines are available for 2640 minutes per week. The products are sold for Rs 200 and Rs 175 respectively per unit. Formulate a LP to maximize revenue? The market can take a maximum of 150 units of product 1.	**04**
	(c)	What is linear programming problem? Discuss the scope and role of LPP in solving management problems.	**07**
Q.2	**(a)**	What are the assumptions in LPP?	**03**
	(b)	Solve following problem with graphical method. Maximize $Z = 3X1 + 9X2$ Subject to $X1 + 4X2 \leq 8$, $X1 + 2X2 \leq 4$ and $X1, X2 \geq 0$	**04**
	(c)	Solve the following problem using Big M method Maximize $Z = 4X1 + 5X2$ Subjects to $2X1 + 3X2 \leq 6$, $3X1 + X2 \geq 3$, $X1, X2 \geq 0$.	**07**
		OR	
	(c)	Using Simplex method solve the following LPP. Maximize $Z = 5X1 + 4X2$ Subject to $X1 - 2X2 \leq 1$, $X1 + 2X2 \geq 3$ and $X1, X2 \geq 0$	**07**
Q.3	**(a)**	Briefly explain about unbalanced assignment problems.	**03**
	(b)	What are trans-shipment problems? Explain with suitable example.	**04**
	(c)	Solve the following transportation problem. Obtain the initial basic feasible solution by Vogel's method and optimal solution by MODI method.	**07**

	D1	D2	D3	D4	Supply
S1	3	2	4	1	20
S2	2	4	5	3	25
S3	4	3	1	4	15
S4	3	5	2	6	40
Demand	25	20	30	25	

OR

Q.3	**(a)**	Discuss various methods of getting IBFS in transportation problem.	**03**
	(b)	How will you define transportation problem? Give mathematical statement of problem explaining each term.	**04**

(c) Solve the following assignment problem for assigning jobs to workers. **07**

		Jobs			
		A	B	C	D
Workers	1	50	70	60	80
	2	80	50	70	100
	3	40	70	60	90
	4	100	40	30	110

Q.4 **(a)** Write down mathematical formula for game theory. **03**

(b) Explain the queuing model as indicated by the following notations. M/D/1 : FCFS/∞/∞ **04**

(c) Vehicles arrive at a toll-booth at a rate of 8 per minute. The serving capacity of operator at toll-booth is 10 vehicles per minute. Find out (i) utilization factor (ii) idle time for booth operator in an 8 hour shift (iii) number of vehicles waiting in the system (iv) number of persons waiting in the queue (v) average waiting time in the queue and (vi) total time spent by a vehicle in the system **07**

OR

Q.4 **(a)** Define the elements of Queuing system. **03**

(b) What are types of strategies for game theory? **04**

(c) As new automobile vehicle costs Rs. 10000 and it can be sold at the end of any year with the selling price as shown. The operating and maintenance cost are given year wise in following table. Find when the automobile vehicle needs to be replaced because of wear and tear. **07**

Year	1	2	3	4	5	6
Selling Price (Rs)	7000	6000	5000	3500	2500	1000
Operating & Maintenance Cost (Rs)	1000	1400	1600	2000	3000	3500

Q.5 **(a)** Explain Kendall's notation for queuing system. Also explain the terms: balking and jockeying **03**

(b) Describe some important replacement situations. **04**

(c) Solve the following 4 X 4 game using rule of dominance. **07**

		Player B			
		1	2	3	4
Player A	1	5	4	3	2
	2	6	2	5	4
	3	1	4	2	0
	4	3	5	3	2

OR

Q.5 **(a)** Differentiate between CPM and PERT **03**

(b) Explain various steps involved in decision making **04**

(c) A project schedule has the following characteristic: Construct a network diagram and find critical path, total duration of the project, various time estimates. **07**

Activity	Duration	Activity	Duration
1-2	3	4-8	6
1-4	2	5-6	5
1-7	1	6-9	4
2-3	3	7-8	4
3-6	2	8-9	5
4-5	4		

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Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE – SEMESTER- V EXAMINATION-SUMMER 2023

Subject Code: 3151910 Date: 01/07/2023

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)**	Define OR. Discuss the origin and development of OR.	**03**
	(b)	Discuss Various phases in solving an OR problems.	**04**
	(c)	Explain the Scope of OR in the various sectors.	**07**
Q.2	**(a)**	What are the applications of LPP?	**03**
	(b)	Define. I. Basic Feasible Solution II. Objective Function III. Degenerate Solution IV. Optimal Feasible Solution	**04**
	(c)	Solve the following LPP by Simplex Method. Maximize $Z= 70x_1 + 150x_2$ Subject to $4x_1 + 6x_2 \leq 84$ $0.5x_1 + x_2 \leq 60$ and $x_1, x_2 \geq 0$	**07**
		OR	
	(c)	Find dual of the following LPP: Minimize $Z = 5x_1 – 6x_2 + 4x_3$ Subject to $3x_1 + 4x_2 + 6x_3 \geq 9$ $x_1 + 3x_2 + 2x_3 \geq 5$ $7x_1 – 2x_2 – x_3 \leq 10$ and $x_1, x_2, x_3 \geq 0$	**07**
Q.3	**(a)**	How will you define transportation problem? Give mathematical statement of problem explaining each term.	**03**
	(b)	Discuss various methods of getting IBFS in transportation problem.	**04**
	(c)	Find out optimal solution for following transportation problem.	**07**

	1	2	3	4	5	6	Supply
A	9	12	9	6	9	10	50
B	7	3	7	7	5	5	60
C	6	5	9	11	3	11	20
D	6	8	11	2	2	10	90
Demand	40	40	60	20	40	20	220

OR

Q.3 **(a)** Define. **03**

I. Discount Rate
II. Money Value
III. Present worth factor

(b) Discuss about the individual replacement versus group replacement. **04**

(c) A printer costing RS. 6500 initially has maintenance & resale value as given below: **07**

Year (n)	1	2	3	4	5	6	7
Resale Value (s)	3000	2500	2000	1500	1000	700	500
Maintenance cost F (t)	100	250	500	1000	1500	1800	2000

Q.4 **(a)** A postman has to visit four societies of an area. He does not want to visit any society twice before completing the visit of all societies from starting one. Following is the matrix showing distance (in kms) of his journey. Suggest him such that his constraint is fulfilled as well as it takes least time. **07**

	I	II	III	IV
I	-	0.420	0.920	0.620
II	0.520	-	1.520	0.420
III	0.520	0.620	-	0.320
IV	0.820	0.920	1.420	-

(b) Solve the following assignment problem for assigning jobs to workers. **07**

Jobs

Workers	A	B	C	D
1	50	70	110	60
2	80	50	90	60
3	40	70	100	70
4	100	40	80	30

OR

Q.4 **(a)** Define the elements of Queuing system. **03**

(b) Explain Kendal's notation for Queuing system. **04**

(c) At barber's shop, the customers arrive at the average interval of 6 minutes, and the barber takes on an average 5 minutes for serving the person. Calculate: **07**

1. Counter utilization level
2. Average number of customers in the including at service system
3. Average number of customers in the queue
4. Average waiting time of customers in the system
5. Expected average waiting time in the queue

Q.5 **(a)** Write down mathematical formula for game theory. **03**

(b) What are types of strategies for game theory? **04**

(c) Solve the following pay-off matrix for player A. Also find out the optimal strategies and value of the game using algebraic method. **07**

Player B

Player A	B1	B2	B3
A1	275	-50	-75
A2	125	130	150

OR

Q.5 **(a)** Define. **03**

I. Event
II. Activity
III. Total float with respect to CPM/PERT

(b) Explain term "Crashing of network". Why it is required? **04**

(c) The activities A to H for a new project having relationships and timings shown in table below. **07**

Relation between Activities

A<C, D B<E C<F D<F E, F<H

1. Draw the network.
2. Find the critical path & expected time of completion of the project.
3. What will be the standard deviation of the project completion duration?
4. What will be the probability of completing the project in expected time of completion?

Duration (in days)

Activity	to	tm	tp
A	2	2	8
B	2	5	8
C	3	6	15
D	2	5	14
E	1	1	7
F	2	2	8
G	2	2	8
H	2	5	14

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Seat No.: _____ Enrolment No._____

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 $Z= 10\ x_1 +15\ x_2$

Subject to, $2\ x_1 + x_2 \leq 26$

$2\ x_1 + 4x_2 \leq 56$

$x_1 - x_2 \geq -5$

$x_1,\ x_2 \geq 0$

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	0	7/6	-8/3	1	-7/6	8/3	-1	8
x2	1/2	0	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	
Δj		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: $Z = 2x_1 + 4x2$

Subject to $2\ x_1 + x_2 \leq 18$

$3\ x_1 + 2x_2 \geq 30$

$x_1 + 2x_2 = 26$ 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). Using assignment techniques find… **07**

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 **07**
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:

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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