

Enrollment No./Seat No.:

GUJARAT TECHNOLOGICAL UNIVERSITY
Bachelor of Engineering - SEMESTER - V EXAMINATION - WINTER
2025

Subject Code: 3151910

Date: 29-11-2025

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.**

	Marks
Q.1 (a) Explain limitations of operation research.	03
(b) Discuss Various phases in solving an OR problems.	04
(c) Use graphical method to solve the following LPP:	07

$$\text{Maximize } Z = 20x_1 + 10x_2$$

$$\text{Subject to } x_1 + 2x_2 \leq 40$$

$$3x_1 + x_2 = 30$$

$$4x_1 + 3x_2 \geq 60 \text{ and } x_1, x_2 \geq 0$$

Q.2 (a) Discuss relationship regarding primal and dual solution.	03
(b) A firm manufactures two product A & B on which the profit earned per unit are Rs. 3 and Rs. 4, respectively. Each product is processed on two machines M1 and M2. Product A requires one minute of processing time on M1 and two minutes on M2, while product B requires one minute of processing time on M1 and one minute on M2. Machine M1 is available for not more than 7 hours and 30 minutes while machine M2 is available for 10 hours during any working day. Formulate the problem as LPP.	04
(c) Solve the following LPP by Big-M method:	07

$$\text{Minimize } Z = -3x_1 + x_2 - 2x_3$$

$$\text{Subject to } x_1 + 3x_2 + x_3 \leq 5$$

$$2x_1 - x_2 + x_3 \geq 2$$

$$4x_1 + 3x_2 - 2x_3 = 5$$

$$\text{And } x_1, x_2, x_3 \geq 0$$

OR

(c) Solve the following problem using Simplex Method: 07

$$\text{Maximize } Z = 10x_1 + 15x_2$$

$$\text{Subject to } 2x_1 + x_2 \leq 26$$

$$2x_1 + 4x_2 \leq 56$$

$$x_1 - x_2 \geq -5$$

$$\text{And } x_1, x_2 \geq 0$$

Q.3 (a) How profit maximization problem can be solved in assignment technique? 03

(b) Consider the transportation problem shown in table below. Find the initial basic feasible solution using Northwest corner method. 04

	1	2	3	4	5	Supply
1	20	4	32	28	20	3000
2	12	36	24	26	32	5000
3	16	8	28	24	20	8250
4	28	44	40	16	36	3750
Demand	3500	4000	2500	1500	4000	

(c) Solve the following assignment problem by minimization method 07

	I	II	III	IV	V
M1	12	5	9	18	11
M2	13	7	6	12	14
M3	3	2	3	4	5
M4	18	9	12	16	15
M5	12	6	14	19	10

OR

(a) What is degeneracy in transportation problem? 03

(b) A chemical company distributes its products by trucks loaded at its only loading station and loading station is working 24 hours, continuously. 04
Both company's trucks and contractor's trucks are used for this purpose. It was found out that on an average 10 minutes one truck arrived and average loading time is 6 minutes. If 50% trucks are contractor's trucks find:

1. Traffic intensity factor;
2. Waiting time of trucks in system;

The expected waiting time of contractor's trucks per day.

- (c) A transportation company has 5, 10, 7 and 3 trucks available at four different sites A, B, C and D. Its customers have requirement of 5, 8 and 10 trucks at the three different destinations X, Y and Z respectively. The distance (in kms.) from an origin to destination is summarized in the following table. Formulate above problem as transportation problem and determine strategy for a company using VAM. Test the optimality of VAM solution and determine optimum strategy for the transport company. 07

	X	Y	Z
A	70	30	60
B	40	60	80
C	50	80	40
D	80	40	30

- Q.4 (a)** What do you understand by zero sum with reference to game theory? Explain saddle point in brief. 03
- (b) A copy maker has one copy making machine and he operates as the order comes. The order arrival is poisson distribution having interval time of 0.5 min. The average time to serve a copy is distributed with mean of 0.3 min. Determine the following: 04
1. Utilization factor of the machine
 2. Idle time for machine in a day having working hours of 10 hours
 3. No. of persons waiting in the system
 4. No. of persons waiting in the queue

Average waiting time in the queue

- (c) Company has purchased machine A costing Rs. 4500 and it has estimated operating cost of Rs. 100 for the first year increasing by Rs. 1000 per year in the second and subsequent years. Now, after six months due to technological advancement machine B was introduced costing Rs. 5000. Its operating cost is Rs. 200 for the first year, increasing by Rs. 400 in second year and subsequent years. Now, company is thinking to buy the machine B. Suggest him optimal time. Consider resale value as zero for both machines. 07

OR

- (a) What is strategy? Explain the difference between pure and mixed strategy. 03
- (b) Draw algorithm to solve the assignment problem. 04
- (c) Explain briefly the difference in replacement of items which deteriorates gradually and items which fails completely that too suddenly. 07
- Q.5 (a)** Mention any two limitations of critical path. 03
- (b) What is EMV? How is it computed to be used a criterion of decision making and when? 04

- (c) The following table give the duration in days and the predecessor for the various tasks. Draw the network diagram and find the minimum time for completion of the project. 07

Task	A	B	C	D	E	F	G	H	I
Time(Days)	8	10	8	10	16	17	18	14	9
Predecessor	-	-	-	A	A	B,D	C	C	F,G

OR

- (a) Explain predecessor, successor and dummy activity with diagram. 03
- (b) What do you mean by saddle point? How it is found out? 04
- (c) A small project is composed of 7 activities whose time estimates are listed in the table below. Activities are identified by their beginning and ending node numbers: 07

A small project is composed of 7 activities whose time estimates are listed in the table below. Activities are identified by their beginning and ending node numbers:

Activity	t_o	t_m	t_p	Activity	t_o	t_m	t_p
1-2	1	1	7	3-5	2	5	14
1-3	1	4	7	4-6	2	5	8
1-4	2	2	8	5-6	3	6	15
2-5	1	1	1				

- i. Draw the project network.
- ii. Find the expected duration and variance of each activity.
- iii. What is the expected project length and standard deviation?
- iv. What is the probability that the project will be completed 3 weeks later than expected time?

GUJARAT TECHNOLOGICAL UNIVERSITY**BE- SEMESTER-V (NEW) EXAMINATION – WINTER 2024****Subject Code:3151910****Date:12-12-2024****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.

MARKS

- Q.1**
- (a) Write the characteristics of Operations Research. **03**
- (b) Discuss the limitations of linear programming problems. **04**
- (c) Sketch the graphical representation of: 1) Infeasible solution, 2) Redundant constraint. **07**

- Q.2**
- (a) Write the steps involved in dynamic programming. **03**
- (b) Explain with example: 1) slack variable, 2) Artificial variable in context of simplex method for LPP. **04**
- (c) The following diet chart shows that amount of two vitamins per unit present in two different foods. Formulate primal and dual as well as write the economic interpretation of both. **07**

Vitamin	Food		Requirement of vitamins units per day
	Spinach	Potato	
A	6	8	100
C	7	12	120
Cost / unit of food	12	20	

OR

- (c) Find initial basic feasible solution by North-west corner method and Least cost method of following transportation problem. Also make comparative comments on obtained solutions. **07**

	D1	D2	D3	D4	Supply
S1	19	30	50	10	7
S2	70	30	40	60	9
S3	40	8	70	20	18
Demand	5	8	7	14	34

- Q.3**
- (a) “Transportation problem is an special case of LPP” Justify the statement. **03**
- (b) Explain the meaning of unbalanced situation of transportation problem using suitable example. **04**
- (c) The supervisor has to assign five machines for operation each. The cost for each operation on each machine is as shown in table. How should supervisor allocate the machine so the total cost can minimize. **07**

Machine	Operation				
	O1	O2	O3	O4	O5
M1	10	3	3	2	8
M2	9	7	8	2	7
M3	7	5	6	2	4
M4	3	5	8	2	4
M5	9	10	9	6	10

OR

- Q.3** (a) Write the canonical form of transportation problem. **03**
 (b) Write the difference between transportation and assignment problems. **04**
 (c) Customers arrive at counter manned by a single person according to a Poisson process with a mean rate of 10 per hour. The time required to serve a customer has an exponential distribution with a mean of 100 seconds. Find the average waiting time of a customer in queue and the system. **07**

- Q.4** (a) Classify the Queuing models. **03**
 (b) Explain how theory of replacement we used in replacement of items whose maintenance cost varies with time. **04**
 (c) The cost of machine is Rs 60000 and its scrap value is of Rs 1000. The maintenance costs based on past experience are as follow. Find the year of replacement for machine. **07**

Year	1	2	3	4	5	6	7	8
Maintenance Cost (Rs)	1000	2500	4000	6000	9000	12000	16000	20000

OR

- Q.4** (a) Define in context of game theory: strategy, Player **03**
 (b) Discuss the characteristics of game theory. **04**
 (c) The estimated profit from type of crop depends on amount of rainfall as given in following table. If farmer prefer to plant only one crop then suggest best crop option under high, medium and low rainfall condition. Also write the name of decision making environment which has been considered for suggestions. **07**

Rainfall	Conditional profit (Rs)		
	Crop A	Crop B	Crop C
High	8000	3500	4500
Medium	3500	4500	5000
Low	2000	5000	3000

- Q.5** (a) Define: Activity, Dummy activity **03**
 (b) Write the procedure steps for the Hurwicz criterion. **04**
 (c) Draw a network for following project; **07**

Activity	A	B	C	D	E	F	G	H
Predecessor	-	A	A	B	B,C	E	D, F	G

OR

- Q.5** (a) Explain the term “Looping” in context of networks scheduling **03**
 (b) Differentiate between forward and backward planning **04**
 (c) Discuss the differences among decision under certainty, decision under risk and decision under uncertainty. **07**

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-V (NEW) EXAMINATION – WINTER 2023****Subject Code:3151910****Date:18-12-2023****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.

- | | | Marks |
|------------|---|-----------|
| Q.1 | (a) What is Operation Research? Discuss the scope of operation research in brief. | 03 |
| | (b) Explain how and why operation research have been valuable in adding executive decision | 04 |
| | (c) A pen manufacturer has two models. A basic model (A) and a standard model (B). Each pen of type B takes twice as long as one of type A and the company would have time to make a maximum of 2000 pen per day if only the basic model A is produced. Supply of plastic is sufficient to produce 1500 pen per day both A and B combined.
The standard version of pen B requires additional accessories of which there are 600 set per day available.
If the company makes a profit of Rs 3 and Rs 5 per pen of type A and B respectively, how many pens of type A and B each will have to be produced to maximize the profit? | 07 |
| Q.2 | (a) Explain the relationship between stages and states in dynamic programming | 03 |
| | (b) Define the following terms associated with customers waiting in queue.
Balking, Reneging, Jockeying, Collusion | 04 |
| | (c) A manufacturing company produce two product A and B. Each product undergoes through operation on machine X and Y. The time required to perform these operations with the available capacity of machines X and Y in a given quarter are given below. The market survey has predicted that not more than 450 units of product A and not more than 250 of product B can be sold in the given quarter. The company wants to determine the product mix to maximize profit. The unit profits for product A and B are Rs 20 and Rs 40 respectively. | 07 |

Machine	Product time required per unit		Available capacity (Hrs)
	A	B	
X	1.5 Hrs.	1 Hrs.	750
Y	1 Hrs.	3 Hrs.	900
Profit	Rs 20	Rs 40	

Formulate the problem and solve graphically.

OR

- (c) Minimize $z = 3x_1 + 5x_2$ **07**

Subject to $4x_1 + 2x_2 \leq 12$ $2x_1 + 2x_2 = 10$ $2x_1 + 5x_2 \geq 10$

Use Big – M method to solve the LPP.

- Q.3 (a)** What do you understand by a balanced and unbalanced transportation problem? How unbalanced problem is tackled? **03**
- (b)** Explain the steps involved in Modified Distribution method **04**
- (c)** A captain of cricket team has to allot five middle order batting position to five batsmen. The average runs scored by each batsman at this position are given in table. **07**

Batting Position

	III	IV	V	VI	VII
A	40	40	35	25	50
B	42	30	16	25	27
C	50	48	40	60	50
D	20	19	20	18	25
E	58	60	59	55	53

Make the assignment so that the expected total average runs scored by these batsmen are maximum.

OR

- Q.3 (a)** Explain the difference between a transportation problem and an assignment problem. **03**
- (b)** Describe the mathematical formulation of an assignment problem. **04**
- (c)** Manufacturing firm has three plant A, B and C and three ware house P, Q and R. Their plants capacities and ware house demand and transportation cost per unit is shown in table. **07**

To	P	Q	R	Capacity
From				
A	11	9	6	40
B	12	14	11	50
C	10	8	10	40
Demand	55	45	30	130

Find the most economical shipment to minimize the total transportation costs. There is no condition any plant can transport the product to any ware house.

- Q.4 (a)** What is strategy? Explain the difference between pure and mixed strategy. **03**
- (b)** Customer arrives at barber's shop according to poisson process with a mean inter arrival time of 20 minutes. Customer spend an average time of 15 minutes in the barber's chair. **04**
1. What is the probability that a new arrival need not to wait for the barber to be free?
 2. What is the expected number of customers in the barber's shop?
 3. How much time can a customer expect to wait for his turn?
 4. How much time can a customer expect to spend in the shop?
- (c)** A manufacturer, find from his past records that the costs per year associated with a machine with a purchase price of Rs 50,000 are as given below: **07**

Year	1	2	3	4	5	6	7	8
Running cost Rs (Maintenance Cost)	15000	16000	18000	21000	25000	29000	34000	40000
Scrap Value	35000	25000	17000	12000	10000	5000	4000	4000

Determine the optimum policy.

OR

- Q.4 (a)** What do you understand by zero sum with reference to game theory? Explain saddle point in brief. **03**

- (b) Describe kendell's notation in respect of queuing theory **04**
 (c) Assume that present value of one rupee to be spent in a year's time is Rs 0.90 **07**
 and capital cost of equipment is Rs 6000. Running costs are given in the table:

Year	1	2	3	4	5	6	7
Running Cost	1000	1200	1600	2000	2600	3200	4000

When should the machine be replaced?

- Q.5** (a) Explain various steps involved in decision making. **03**
 (b) Differentiate between CPM and PERT **04**
 (c) A project schedule has the following characteristic: **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		

Construct a network diagram and find critical path, total duration of the project, various time estimates.

OR

- Q.5** (a) What is the difference between decision making under certainty, under uncertainty and under risk **03**
 (b) Define: Activity, Event, Dummy activity, Float **04**
 (c) A small project is composed of 7 activities whose time estimates are listed in the below table. Activities are identified by their beginning and ending nodes members **07**

Activity		1-2	1-3	1-4	2-5	3-5	4-6	5-6
Time	Optimistic	1	1	2	1	2	2	3
Estimates	Most Likely	1	4	2	1	5	5	6
Week	Pessimistic	7	7	8	1	14	8	15

1. Draw Project Network
2. Find the expected duration and variance for each activity
3. What is the expected project length and standard deviation?
4. What is the probability that the project will be completed 3 weeks later than the expected time?

GUJARAT TECHNOLOGICAL UNIVERSITY**BE - SEMESTER-V (NEW) EXAMINATION – WINTER 2022****Subject Code:3151910****Date:19-01-2023****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.

MARKS

- Q.1**
- (a) State and explain various characteristics of Linear Programming. **03**
- (b) Write the general mathematical formulation of a LP Problem. **04**
- (c) Find the maximum value of $Z = 20 X_1 + 10 X_2$ by graphical method; **07**
- Subject to: $X_1 + 2 X_2 \leq 40$
- $3X_1 + X_2 \geq 30$
- $4X_1 + 3X_2 \geq 60$ Where, $X_1, X_2 \geq 0$.

- Q.2**
- (a) Briefly explain 'Decision Tree'. **03**
- (b) Discuss the difference between decision-making under certainty and under conflict. **04**
- (c) Describe the computational procedure of Two-phase method. **07**

OR

- (c) Solve the following problem by simplex method; **07**
- Maximize; $Z = 3X_1 + 2X_2 + 5X_3$
- Subject to: $X_1 + 2X_2 + X_3 \leq 430$
- $3X_1 + 2X_3 \leq 460$
- $X_1 + 4X_2 \leq 420$. Where, $X_1, X_2 \geq 0$.

- Q.3**
- (a) Briefly explain about unbalanced assignment problems. **03**
- (b) Describe the procedure to solve travelling salesman problem. **04**
- (c) Solve the following transportation problem. Obtain the initial basic feasible solution by Vogel's method and optimal solution by MODI method. **07**

	M ₁	M ₂	M ₃	M ₄	Supply
F ₁	3	2	4	1	20
F ₂	2	4	5	3	15
F ₃	3	5	2	6	25
F ₄	4	3	1	4	40
Demand	30	20	25	25	

OR

- Q.3**
- (a) Explain: Transportation problems with prohibited routes. **03**
- (b) What are trans-shipment problems? Explain with suitable example. **04**
- (c) Solve the following assignment problem. **07**

Workers	Jobs		
	A	B	C
1	110	140	60
2	80	100	110
3	90	120	70
4	100	130	80

- Q.4 (a)** Explain the queuing model as indicated by the following notations. **03**
M/D/1 : FCFS/ ∞ / ∞
- (b)** Define: Queue and give its classification. Mention applications of each type of queue. **04**
- (c)** Solve the following 4 X 4 game using rule of dominance. **07**

		Player B			
		I	II	III	IV
Player A	I	3	5	4	2
	II	5	6	2	4
	III	2	1	4	0
	IV	3	3	5	2

OR

- Q.4 (a)** List the different methods for solving Game Problems. **03**
- (b)** Write the important assumptions of “Game Theory”. **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**

- Q.5 (a)** Define event, activity and dangling with respect to project management. **03**
- (b)** Explain D.R. Fulkerson’s rule for network diagram. **04**
- (c)** A vehicle having initial cost of Rs. 50,000 has the following data based on past experience: **07**

Year	1	2	3	4	5	6	7
Maintenance cost in Rs.	5,000	6,000	7,000	9,000	11,500	16,000	18,000
Resale value in Rs.	30,000	15,000	7,500	3,750	2,000	2,000	2,000

Calculate replacement time of the vehicle.

OR

- Q.5 (a)** Describe some important replacement situations. **03**
- (b)** Differentiate between CPM and PERT. **04**
- (c)** Determine the critical path for given project schedule and find out total float for each event. **07**

Activity	Time (weeks)	Activity	Time (weeks)
1-2	10	4-6	9
1-3	6	4-8	8
1-4	7	5-7	7
2-5	3	6-7	15
2-6	3	7-9	4
3-8	12	8-9	6
