

Seat No./Enrollment No.: _____

GUJARAT TECHNOLOGICAL UNIVERSITY
BACHELOR OF ENGINEERING – SEMESTER 5 – EXAMINATION – SUMMER 2026

Subject Code: 3151910

Date: 04/06/2026

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.

- Q.1**
- (a) Briefly explain the characteristics of Operations Research. 03
- (b) Find the dual of 04
Maximize $Z = 3.X_1 + 2.X_2$
Subject to, $X_1 + X_2 \geq 1$
 $X_1 + X_2 \leq 7$
 $X_1 + 2X_2 \leq 10$
 $X_2 \leq 3$
 $X_1, X_2 \geq 0$
- (c) A firm makes two products A and B, and has a total production capacity of 9 tonnes per day. The firm has a permanent contract to supply at least 2 tonnes of A and at least 3 tonnes of B per day to another company. Each tonnes of A requires 20 machine hours of production time and each tonnes of B requires 50 machine hours of production time. The daily possible number of machine hours is 360. All the firms output can be sold and the profit made is Rs. 80 per tonnes of A and Rs. 120 per tonnes of B. Formulate the linear programming problem to maximize profit and evaluate profit using graphical method. 07

- Q.2**
- (a) Explain the procedure of solving a problem using dynamic programming. 03
- (b) Explain the concept of crashing in project networks. Why is it necessary? 04
- (c) A project schedule has the following characteristics. 07

Activities	Duration	Activities	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, determine critical path and total duration of the project. Further calculate the total float for each activities.

OR

Q.2

- (c) The following table gives the activities in a construction project and other related information.

07

Activity	Optimistic time (day)	Most likely time (day)	Pessimistic time (day)
1-2	20	30	46
1-3	9	12	21
2-3	3	5	7
2-4	2	3	4
3-4	1	2	3
4-5	12	18	24

Draw a PERT diagram. Evaluate the critical path and calculate total project duration. Further estimate the probability that the project will be completed in 50 days.

- Q.3 (a) Describe the concept of degeneracy as it occurs in transportation problems. 03
- (b) Determine initial basic feasible solution of the following transportation problem using least cost method. 04

Plants	Warehouses			Capacity
	P	Q	R	
A	35	25	15	875
B	10	20	30	575
Demand	350	350	450	

- (c) A captain of a cricket team has to allot free middle over batting positions to five batsmen. The average runs scored by each batsman at these positions are given in the following table.

07

		Batting position				
		III	IV	V	VI	VII
Batsman	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

Apply the appropriate optimization method to assign batting positions to batsmen so that the total average runs scored by these batsmen is maximized.

OR

- Q.3 (a) Explain the concept of a transshipment problem and how it can be represented and solved using a transportation problem framework. 03
- (b) Determine an initial basic feasible solution to the following transportation problem using VAM method. 04

Warehouse		Stores				Availability
		I	II	III	IV	
	A	7	3	5	5	34
	B	5	5	7	6	15
	C	8	6	6	5	12
	D	6	1	6	4	19
	Demand	21	25	17	17	80

- (c) The manager of a company has to assign four jobs to three persons. The persons differ in efficiency. The estimates of the time each person would take to perform a task are given in the following matrix. 07

		Person		
		1	2	3
Jobs	I	9	26	15
	II	13	27	6
	III	35	20	15
	IV	18	30	20

Apply the appropriate optimization method to assign jobs to persons so that the total man-hours is minimized.

- Q.4 (a) Define the following terms associated with customers waiting in queue: Reneging, Jockeying, Collusion. 03
- (b) Discuss the characteristics of game theory. 04
- (c) The payoff matrix for a particular competitive situation is as under: 07

		B		
		I	II	III
A	I	7	6	3
	II	-2	2	-3
	III	5	9	7

(i) Reduce the size of the game to 2 x 2 matrix by method of dominance. (ii) Determine the optimal strategies. (iii) Calculate value of the game.

OR

- Q.4 (a) Describe the method of dealing with a non-square matrix in an assignment problem with the help of an example. 03
- (b) What do you understand by zero sum with reference to game theory? Explain saddle point in brief. 04
- (c) The maintenance cost and resale value per year of a machine whose purchase price is ₹ 7,000 is given in below table. Apply appropriate replacement theory to decide the year for replacement of machine. 07

Year	1	2	3	4	5	6	7	8
Maintenance cost (₹)	900	1,200	1,600	2,100	2,800	3,700	4,700	5,900
Resale value (₹)	4,000	2,000	1,200	600	500	400	400	400

- Q.5 (a) Briefly explain 'Decision Tree'. 03
- (b) The research department of Marico company has recommended to the marketing department to launch a shampoo of three different types. The marketing manager has to decide one of the types of shampoo to be launched under the following estimated pay off's for various levels of sales. What will be the marketing manager's decision if (i) Maximin (ii) Regret criterion are applied. 04

Types of shampoo	Estimated level of sales (units)		
	15000	10000	5000
Egg Shampoo	30	10	10
Clinic Shampoo	40	15	5
Delux Shampoo	55	20	3

(c) Solve the following linear programming problem using simplex method.

07

Maximize, $Z = 30.X + 20.Y$

Subject to $3X + Y \leq 1500,$

$X + Y \leq 3000$

$X, Y \geq 0$

OR

Q.5 (a) Discuss group replacement policy with suitable example. 03

(b) A large service station has a store room from where the service mechanics take the parts for the jobs they work upon. The mechanics wait in the line to get the parts that they need. The store is manned by one attendant who can, on an average, attend 7 mechanics per hour. It is observed that, on an average, the mechanics' average arrival rate at the store room is 5 per hour. Assuming that the pattern of mechanic's arrivals is Poisson distributed and the servicing time is exponentially distributed, determine (i) the expected number of mechanics in the system. (ii) the expected number of mechanics waiting in the queue. (iii) the expected time that a mechanics has to spend in the queue,. (iv) the expected time that a mechanics spends in the system. 04

(c) Solve the following linear programming minimization problem using the two-phase method. 07

Minimize $Z = 45.X_1 + 28.X_2$

Subject to $20.X_1 + 50.X_2 \geq 3600,$

$80.X_1 + 50.X_2 \leq 6000,$

$X_1, X_2 \geq 0$
