

OPERATIONS RESEARCH
(MECH 4143)

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve:

12 × 1 = 12

Choose the correct alternative for the following

- (i) Simplex method of solving linear programming problem uses
(a) all the points in the feasible region
(b) only the corner points of the feasible region
(c) intermediate points within the infeasible region
(d) only the interior points in the feasible region.
- (ii) Which one of the following statements is not correct?
(a) A linear programming problem with 2 variables and 3 constraints can be solved by Graphical Method
(b) In Big-M method if the artificial variable can not be driven out it depicts an optimal solution
(c) Dual of a dual is the primal problem
(d) For mixed constraints Big-M method can be employed.
- (iii) The supply at three sources is 50, 40 and 60 units respectively whilst the demand at the four destinations is 20, 30, 10 and 50 units. In solving this transportation problem
(a) A dummy source of capacity 40 units is needed
(b) A dummy destination of capacity 40 units is needed
(c) No solution exists as the problem is infeasible
(d) None solution exists as the problem is degenerate.
- (iv) In an assignment problem having n facilities and n jobs, what is the number of possible ways of making assignments?
(a) n! (b) n² (c) 2n (d) 2ⁿ
- (v) The value of the coefficient of optimism (α) is needed while using the criterion of
(a) maximin (b) equally likely (c) realism (d) minimax.
- (vi) In a network diagram, activity is denoted by
(a) Node (b) Arrow (c) Triangle (d) Rectangle.

- (vii) PERT stands for
 (a) Performance Evaluation Review Technique
 (b) Programme Evaluation Review Technique
 (c) Programme Evaluation Research Technique
 (d) Performance Evaluation Research Technique.
- (viii) A feasible solution to the linear programming problem should
 (a) Satisfy the problem constraints
 (b) Optimize the objective function
 (c) Satisfy the problem constraints and non-negativity restrictions
 (d) Satisfy the non-negativity restrictions.
- (ix) Hungarian algorithm is used to solve
 (a) Transportation problem
 (b) Assignment problem
 (c) Unconstrained non-linear programming problem
 (d) Constrained non-linear programming problem.
- (x) An activity is critical if its _____ float is zero.
 (a) total (b) free (c) independent (d) interference

Fill in the blanks with the correct word

- (xi) In network diagrams, events are commonly represented by _____.
- (xii) An activity which must be completed before commencement of one or more other activities is called _____ activity.
- (xiii) If the operating characteristics of a queue are independent on time, then it is said to be in a _____ state.
- (xiv) The unit of traffic intensity is _____.
- (xv) In a LPP, the dual of a dual is _____.

Group - B

2. (a) Explain EPPI. [[CO1](Understand/LOCQ)]
 (b) Describe very briefly about any three types of decision making environments. [[CO1](Remember/LOCQ)]
 (c) Differentiate between PERT and CPM. (Any two points) [[CO2](Understand/LOCQ)]
4 + 6 + 2 = 12
3. (a) A company has to choose between two strategies A and B to produce their product. Market analysis revealed that the probability of 5000 annual sales is 30%, probability of 4000 annual sales is 40% and probability of 3000 annual sales is 30%. For type A strategy variable costs and fixed costs are Rs. 10,000 per piece and Rs 8,00,000 annually respectively. Alternatively for type B strategy, variable costs and fixed costs are Rs.9,000 per piece and Rs.50,00,000 annually respectively. If the new boat is to be sold for Rs.11,000, which strategy the company chooses to maximize the expected profits. [[CO1](Analyse/IOCQ)]
 (b) Draw a network diagram on the basis of following data and find out the earliest and latest start and finish time of each activity. [[CO2](Analyse/IOCQ)]

Activity	1-2	1-4	1-7	2-3	3-6	4-5	4-8	5-6	6-9	7-8	8-9	9-10
Time (Days)	2	2	1	4	1	5	8	4	3	3	5	2

$$6 + (2 + 4) = 12$$

Group - C

4. (a) Consider the following Linear programming problem (LPP):

Maximize $w = 11x - z$

Subject to

$$10x + y - z \leq 1$$

$$2x - 2y + z \leq 2$$

$$x, y, z \geq 0$$

Write the dual of the above LPP and use the Graphical method to find the maximum value of w . [[CO3,CO4](Apply/IOCQ)]

- (b) A simple table for a linear programming problem is given below:

	5	2	3	0	0	0	
Basic Variables	x1	x2	x3	x4	x5	x6	RHS
x4	1	2	2	1	0	0	8
x5	3	4	1	0	1	0	7
x6	2	3	4	0	0	1	10

Find the leaving and entering variables in the next iteration of the simplex table.

[[CO4](Evaluate/HOCQ)]

$$(4 + 4) + 4 = 12$$

5. Find the basic feasible solution of the following transportation problem using

(i) North-West corner method

(ii) Vogel's Approximation Method

(iii) Select which method is better to determine the basic feasible solution.

Source	Destinations				Availability
	D1	D2	D3	D4	
S1	1	2	1	4	30
S2	3	3	2	1	50
S3	4	2	5	9	20
Requirements	20	40	30	10	

[[CO5](Analyze/IOCQ)]

$$(5 + 6 + 1) = 12$$

Group - D

6. (a) Define the terms 'Global Minima' and 'Point of Inflection'. [[CO4](Remember/LOCQ)]

(b) $f(x) = 5x_1 + 2x_2^2 + x_3^2 - 3x_3x_4 + 4x_4^2 + 2x_5^4 + x_5^2 + 3x_5x_6 + 6x_6^2 + 3x_6x_7 + x_7^2$

Show that $f(x)$ is convex by expressing it as a sum of functions of one or two variables and then proving that all functions are convex. [[CO4](Analyze/IOCQ)]

$$6 + 6 = 12$$

7. (a) Write a short note on the assignment problem and its applications.

[[CO5](Remember/LOCQ)]

- (b) Solve the following assignment problem. The matrix entries are processing times in hours. [[CO5](Apply/IOCQ)]

		Operator				
		1	2	3	4	5
Job	1	20	22	35	22	18
	2	4	26	24	24	7
	3	23	14	17	19	19
	4	17	15	16	18	15
	5	16	19	21	19	25

4 + 8 = 12

Group - E

8. (a) Explain transient and steady state of the queuing system related to queuing theory. [[CO6](Understand/LOCQ)]
- (b) Cars arrive at a toll gate according to Poisson distribution with mean 90/hour. Average time for passing through the gate is 38 seconds. Drivers complain of long waiting times. Authorities are willing to reduce the passing time to 30 seconds by introducing new automated devices. This can be justified only if the number of cars waiting in the queue exceeds 5. In addition, the percentage of the gate's idle time should not exceed 10%. Can the new device be justified? [[CO6](Evaluate/HOCQ)]
- 4 + 8 = 12**
9. (a) Name the elements of a queuing system. [[CO6](Remember/LOCQ)]
- (b) A repairman to be hired by a company for the machines which break down at an average rate of 3 per hour. following Poisson's distribution. Non productive time of machines costs Rs. 16 per hour. Two repairmen have been interviewed: one is slow but cheap, while other is fast but expensive. The slow repairman charges rs 8 per hour and he repairs at the rate of 4 per hour. The fast repairman demands Rs. 10 per hour but repairs at an average rate of 6 machines per hour. Assuming an 8-hours working day, which repairman should be hired? [[CO4](Evaluate/HOCQ)]
- 6 + 6 = 12**

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	33.33	47.92	18.75

Course Outcome (CO):

After the completion of the course students will be able to

1. Solve operational problems using decision theory approaches.
2. Apply appropriate techniques to analyze a project.
3. Formulate Linear and Nonlinear programming problems to optimize resources.
4. Solve the Linear and Nonlinear programming problems using appropriate techniques.
5. Solve transportation and assignment problems using suitable techniques.
6. Determine the solutions to single channel queuing problems.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.