

QUANTITATIVE DECISION MAKING
(MECH 4221)

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) The EST + activity duration =
(a) Earliest Finish Time (b) Latest Start Time
(c) Latest Finish Time (d) Project completion time.
- (ii) In a network diagram, activity is denoted by
(a) Node (b) Arrow (c) Triangle (d) Rectangle
- (iii) If a decision theory problem has 3 decision alternatives and 4 states of nature, the number of payoffs in that problem will be
(a) 3 (b) 4 (c) 12 (d) 64
- (iv) An activity is critical if its _____ float is zero.
(a) total (b) free (c) independent (d) interference
- (v) MODI method is used to obtain _____
(a) optimal solutions (b) initial basic solutions
(c) both (a) and (b) (d) none of (a), (b) & (c).
- (vi) In graphical representation the bounded region is known as _____ region.
(a) solution (b) basic solution (c) feasible solution (d) optimal
- (vii) An assignment problem is considered as a particular case of a Transportation problem because
(a) the number of rows equals columns (b) all $x_{ij} = 0$
(c) all rim conditions are 1 (d) all of (a), (b) & (c).
- (viii) A dummy activity
(a) is artificially introduced (b) is represented by a dotted line
(c) does not consume time (d) all of (a), (b) & (c).
- (ix) The solution to a transportation problem with m-rows and n-columns is feasible if number of positive allocations are
(a) m+n (b) m+n+1 (c) m x n (d) all of (a), (b) & (c).

- (x) The method used for solving an assignment problem is called
 (a) Reduced matrix method (b) Hungarian method
 (c) MODI method (d) None of (a), (b) & (c).

Fill in the blanks with the correct word

- (xi) An activity which must be completed before commencement of one or more other activities is called _____ activity.
 (xii) The number of decision variables in the primal is equal to the number of _____ in the dual.
 (xiii) The linear function of variables of a linear programming problem which is to be maximized or minimized is called _____.
 (xiv) In case of an unbalanced transportation problem, shipping cost coefficients of _____ are assigned to each created dummy factory or warehouse.
 (xv) The coefficient of slack variable in the objective function is _____.

Group - B

2. (a) A food product company is contemplating the introduction of a revolutionary new product with new packaging to replace the existing product at a large increase in price (P_1) or a moderate change in composition of the existing product with a new packaging at a small increase in price (P_2) or a small change in the composition of the existing product with a negligible increase in price (P_3). The three states of nature are: (i) high increase in sales (N_1), (ii) no change in sales (N_2) and (iii) decrease in sales (N_3). The marketing department of the company worked out the payoffs in terms of yearly net profits for each course of action for these events. This is represented in the following table:

States of nature	Course of action		
	P_1	P_2 (₹)	P_3 (₹)
N_1	(₹) 700000	(₹) 500000	(₹) 300000
N_2	(₹) 300000	(₹) 450000	(₹) 300000
N_3	(₹) 150000	(₹) 0	(₹) 300000

Determine the strategy the company should choose on the basis of

- (i) maximax criterion (ii) maximin criterion
 (iii) minimax regret criterion (iv) Laplace criterion [[CO1](Apply/IOCQ)]
 (b) Write a short note on the value of perfect information. [[CO1](Remember/LOCQ)]
(4 + 4 + 2) + 2 = 12

3. (a) Indicate the differences between decision making under risk and uncertainty in decision theory. [[CO1](Understand/LOCQ)]
 (b) Discuss the advantages and limitations of the decision tree approach. [[CO2](Understand/LOCQ)]
6 + 6 = 12

Group - C

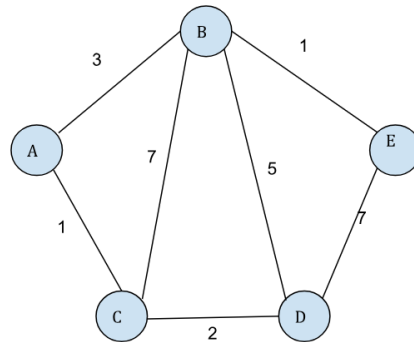
4. (a) Construct a network representing the following project consisting of activities A,B,C,D,E,F,G,H,I and J whose durations of completion are 6, 11, 6, 3, 2, 6, 10, 7 and 8 weeks respectively.

- (i) Activities A, B and C are first to start simultaneously
- (ii) E and D follows A, and F and G follows B and D
- (iii) H follows C and F
- (iv) I follows E
- (v) J follows I and G
- (vi) J and H are terminal activities

Construct the network diagram to compute the critical path and minimum duration of completion of the project. Do the numbering of the nodes by Fulkerson's method. Also find the total float of the activities. [[C03](Apply/IOCQ)]

- (b) Mention any two limitations of the critical path method. [[C03](Remember/LOCQ)]
(6 + 2 + 1 + 1) + 2 = 12

5. (a) Find the shortest path in the given weighted graph by Dijkstra's algorithm.



- (b) Write a short note on crashing of project network.

[[C03](Apply/IOCQ)]
[[C03](Understand/LOCQ)]
6 + 6 = 12

Group - D

6. (a) Solve the following problem using graphical method:

Minimize $Z = 15x_1 + 10x_2$

subject to

$$8x_1 + 4x_2 \geq 360$$

$$3x_1 + 7x_2 \geq 280$$

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

[[C04](Apply/IOCQ)]

- (b) Find out the optimal solution to the following LPP using Simplex method

Maximize $Z = 5x_1 + 10x_2$

subject to

$$3x_1 + 5x_2 \leq 60$$

$$4x_1 + 4x_2 \leq 72$$

$$2x_1 + 4x_2 \leq 100$$

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

[[C04](Apply/IOCQ)]

5 + 7 = 12

7. (a) Two products 'A' and 'B' are to be manufactured. Single unit of 'A' requires 2.4 minutes of punch press time and 5 minutes of assembly time, while a single unit of 'B' requires 3 minutes of punch press time and 2.5 minutes of welding time. The capacity of the punch press department, assembly department and welding department are 1200 min/week, 800 min/week and 600 min/week respectively. The profit from 'A' is ₹60 and from 'B' is ₹70 per unit. Formulate

LPP such that profit is maximized and also find the solution using graphical method.

[[CO4](Evaluate/HOCQ)]

- (b) Find the initial basic feasible solution to the following transportation problem using Vogel's approximation method:

[[CO5](Apply/IOCQ)]

	D1	D2	D3	D4	Supply
S1	11	13	17	14	250
S2	16	18	14	10	300
S3	21	24	13	10	250
S4	14	8	12	12	150
Demand	200	225	275	250	

(3 + 4) + 5 = 12

Group - E

8. (a) Four new machines M_1, M_2, M_3, M_4 and M_5 , are to be installed in a machine shop. There are five vacant places A, B, C, D and E available. Because of limited space, machine M_2 cannot be placed at C and M_3 cannot be placed at A. C_{ij} , the assignment cost of machine i to place j in rupees is shown below.

		Places				
		A	B	C	D	E
Machines	M_1	8	6	3	5	6
	M_2	7	6	-	5	4
	M_3	-	6	9	6	2
	M_4	9	3	7	2	3
	M_5	8	6	8	3	5

Find the optimal assignment schedule.

[[CO5](Evaluate/HOCQ)]

- (b) Determine whether this function is convex, concave or neither:

$$f(X) = 3x_1 + 2x_1^2 + 4x_2 + x_2^2 - 2x_1x_2$$

[[CO6](Analyze/IOCQ)]

7 + 5 = 12

9. Use the method of Lagrangian multipliers to solve the following non-linear programming problem. Does the solution maximize or minimize the objective function?

Optimize $Z = 2x_1^2 + x_2^2 + 3x_3^2 + 10x_1 + 8x_2 + 6x_3 - 100$

Subject to the constraints $x_1 + x_2 + x_3 = 20$ and $x_1, x_2, x_3 \geq 0$

[[CO6](Apply/IOCQ)]

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Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	22.92	62.5	14.58

Course Outcome (CO):

After the completion of the course students will be able to

- CO1** Appreciate the importance of Quantitative Decision Making. Recognize different conditions and implement different decision making tool to take decisions under certain conditions.
- CO2** Solve of game theory problems and evaluate decision tree problems.
- CO3** Identify the resources required for a project and generate a plan and work schedule.
- CO4** Formulate and solve mathematical model (linear programming problem) for a physical situations like production, distribution of goods and economics.
- CO5** Analyze the problems for transporting products from origin to destination with least transportation cost and decide assignments of systems or persons in different situations.
- CO6** Formulate practical situations into non-linear programming problem

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