

QUANTITATIVE DECISION MAKING
(MECH 4221)

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.*

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) Which of the following criterion is not used for decision-making under uncertainty?
(a) Maximin (b) Maximax
(c) Minimax (d) Minimize expected loss.
 - (ii) Decision nodes are represented by
(a) circle (b) square (c) rhombus (d) triangle.
 - (iii) Activities P, Q, and R are the immediate predecessors for activity M. If the earliest finishing times for the three activities are 12, 15, and 10, then the earliest start time for activity M?
(a) 12 (b) 15 (c) 10 (d) Cannot be determined.
 - (iv) The time by which the activity completion time can be delayed without affecting the start of succeeding activities is known as
(a) duration (b) total float (c) free float (d) independent float.
 - (v) Activity in a network diagram is represented by?
(a) Rectangles (b) Arrows (c) Squares (d) Circles.
 - (vi) The initial solution of a transportation problem can be obtained by applying any known method. However, the only condition is that
(a) the solution be optimal (b) the rim conditions are satisfied
(c) the solution not be degenerate (d) all of the above.
 - (vii) Which of the following methods is used to verify the optimality of the current solution of the transportation problem?
(a) Least cost method (b) Vogel's approximation method
(c) Modified distribution method (d) All of the above.

- (viii) _____ or _____ are used to "balance" an assignment or transportation problem.
 (a) Destinations; sources (b) Units supplied; units demanded
 (c) Dummy rows; dummy columns (d) Artificial cells; degenerate cells
- (ix) In simplex method, we add _____ variables in the case of '='
 (a) slack Variable (b) surplus Variable
 (c) artificial Variable (d) none of the above
- (x) Dual of the dual is _____
 (a) primal (b) dual (c) alternative (d) none of the above.

Group - B

2. (a) A dairy firm wants to determine the quantity of butter it should produce to meet the demand. Past records have shown the following demand patterns:

Quantity required (kg)	No. of days demand occurred
15	6
20	14
25	20
30	80
35	40
40	30
50	10

The stock levels are restricted to the range 15 to 50 kg due to inadequate storing facilities. Butter costs Rs. 40 per kg and is sold at Rs. 50 per kg.

- (i) Construct a conditional profit table.
 (ii) Determine the action alternative associated with the maximization of expected profit.
 (iii) Determine EVPI. [[CO1](Create/HOCQ)]
- (b) Various methods useful for decision-making under uncertainty.
[[CO1](Remember/LOCQ)]
(4 + 4 + 2) + 2 = 12

3. (a) The Oil India Corporation is considering whether to go for an offshore oil drilling contract to be awarded in Bombay High. If the bid value would be Rs. 600 million with a 65% chance of gaining the contract, they may set up a new drilling operation or move an already existing operation which has proved successful, to the new site. The probability of success and expected returns are as follows:

Outcome	New drilling operation		Existing operation	
	Probability	Expected revenue (Rs. million)	Probability	Expected revenue (Rs. million)
Success	0.75	800	0.85	700
Failure	0.25	200	0.15	250

If the corporation does not bid or lose the contract, they can use the Rs. 600 million to modernize their operation. This would result in a return of either 5% or 8% on the sum invested with probabilities of 0.45 and 0.55. Assume that all costs and revenues have been discounted to the present value.

- (i) Construct a decision tree for the problem showing clearly the course of action.
- (ii) By applying an appropriate decision criteria to recommend whether or not the Oil India Corporation should bid the contract.
- (iii) What would be the financial return if they bid? [(CO2)(Create/HOCQ)]
- (b) Write any two limitations of 'Game theory'. [(CO2)(Remember/LOCQ)]
- (5 + 3 + 2) + 2 = 12**

Group - C

4. (a) The National Park service plans to develop wilderness areas for tourism. Four locations in the area are designated for automobile access. These sites and the distances (kilometres) between them are listed in the table below. To inflict the least harm on the environment the park service wants to minimize the kilometres of roadway required to provide the desired accessibility. Determine how roads should be built to achieve this objective.

	Park Entrance	Wild falls	Majestic rock	Sunset point	The meadow
Park Entrance		7.1	19.5	19.1	25.7
Wild falls	7.1		8.3	16.2	13.2
Majestic rock	19.5	8.3		18.1	5.2
Sunset point	19.1	16.2	18.1		17.2
The meadow	25.7	13.2	5.2	17.2	

[(CO3)(Apply/IOCQ)]

- (b) Discuss all the four types of floats and also discuss their importance.
- [(CO3)(Understand/LOCQ)]
- 8 + 4 = 12**

5. (a) A small project consists of 7 activities for which the relevant data are given below:

Activity	A	B	C	D	E	F	G
Preceding activity	-	-	-	A,B	A,B	C,D,E	C,D,E
Normal time (days)	4	7	6	5	7	6	5

- (i) Draw the activity network of the project.
- (ii) Find the total float and free float for each activity.
- (iii) Determine the critical path and the project duration.

[(CO3)(Apply/IOCQ)]

- (b) Discuss the rules of Network construction.
- [(CO3)(Understand/LOCQ)]
- 8 + 4 = 12**

Group – D

6. (a) Find the optimal solution of the LPP by Simplex method:

$$\text{Minimize } Z = 16x_1 + 10x_2$$

subject to

$$20x_1 + 12x_2 \geq 200$$

$$4x_1 \geq 20$$

$$4x_2 \geq 20$$

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

[(CO4)(Analyze/IOCQ)]

- (b) Solve the following problem using graphical method:

$$\text{Maximize } Z = -x_1 + 2x_2$$

subject to

$$x_1 - x_2 \leq -1$$

$$-0.5x_1 + x_2 \leq 2$$

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

[(CO4)(Apply/IOCQ)]

$$7 + 5 = 12$$

7. (a) A firm can manufacture three types of cloth namely A, B and C. Three types of wool are required for it; red, green and blue. One unit length of type A cloth needs 2 yards of red wool and 3 yards of blue wool, one unit length of type B cloth needs 3 yards of red, 2 yards of green and 4 yards of blue wool while one unit length of type C needs 5 yards of green wool and 4 yards of blue wool. The firm has a stock of 8 yards of red wool, 10 yards of green wool and 15 yards of blue wool. The income obtained by the firm from one unit length of cloth of type A is Rs. 3, of the type B is Rs. 5 and that of the type C is Rs. 4.

How should the firm allocate the available material so as to maximize total income from the finished cloth? Formulate the linear programming problem.

[(CO4)(Create/HOCQ)]

- (b) A product is produced by four factories A, B, C and D. Their production capacities are factory A-50 units, B-70 units, C- 30 units and D-50 units. These factories supply the product to four stores, demand of which are 25, 35, 105 and 20 units respectively. Unit transport cost in Rs. from each factory to each store is given in the table below.

		Stores			
		U	V	W	X
Factories	A	2	4	6	11
	B	10	8	7	5
	C	13	3	9	12
	D	4	6	8	3

Determine the extent of deliveries from each of the factories to each of the stores so that the total production and transportation cost is the minimum.

[(CO5)(Analyze/IOCQ)]

$$4 + 8 = 12$$

Group – E

8. (a) Five different machines can do any of the five required jobs, with different profit resulting from each assignment. Find the assignment that maximizes the total profit.

		Machines				
		A	B	C	D	E
Jobs	1	30	37	40	28	40
	2	40	24	27	21	36
	3	40	32	33	30	35
	4	25	38	40	36	36
	5	29	62	40	34	39

[(CO5)(Analyze/IOCQ)]

- (b) Find the maximum and/or minimum value of the function $F(X) = 3x^4 + 5x^3$

[(CO6)(Analyze/IOCQ)]

$$7 + 5 = 12$$

9. (a) Solve the following non-linear programming problem graphically,
Maximize $Z = x_1 + 2x_2$
subject to

$$x_1^2 + x_2^2 \leq 10,$$

$$2x_1 + x_2 \leq 2$$

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

[(CO6)(Apply/IOCQ)]

- (b) For the given function determine whether it is convex, concave or neither.

$$f(X) = 2x_1^2 - x_2^2 + x_1x_2 + 3x_1 + 4x_2 + 17.$$

[(CO6)(Analyze/IOCQ)]

$$6 + 6 = 12$$

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	12	63	25

Course Outcome (CO):

After the completion of the course students will be able to

- CO 1** Appreciate the importance of Quantitative Decision Making. Recognize different conditions and implement different decision making tool to take decisions under certain conditions.
- CO 2** Solve of game theory problems and evaluate decision tree problems.
- CO 3** Identify the resources required for a project and generate a plan and work schedule.
- CO 4** Formulate and solve mathematical model (linear programming problem) for a physical situations like production, distribution of goods and economics.
- CO 5** Analyze the problems for transporting products from origin to destination with least transportation cost and decide assignments of systems or persons in different situations.

CO 6 Formulate practical situations into non-linear programming problem

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