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BBA	SEMESTER 4	CALICUT UNIVERSITY	COURSE CODE: BBA4CJ202

DECISION SCIENCE

EXAM REVISION NOTES

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MODULE I

FOUNDATIONS OF DECISION SCIENCE & LINEAR PROGRAMMING MODELING

Nature, Scope, and Methodology of Decision Science: Decision science approaches managerial challenges through a structured scientific methodology consisting of six phases:

- **Problem Identification and Formulation:** Defining operational objectives, identifying key variables, and establishing system boundaries.
- **Mathematical Model Construction:** Translating verbal operational relationships into symbolic equations representing an objective function and structural constraints.
- **Model Derivation / Solution:** , Simplex algorithm, Hungarian method) to identify the optimal solution.
- **Model Validation:** Testing the model against historical data to ensure behavioral stability and accuracy.
- **Sensitivity Analysis:** Evaluating how the optimal solution shifts when external technological or cost parameters fluctuate.

The General Linear Programming Problem (LPP) Formulation: A Linear Programming Problem (LPP) seeks to maximize or minimize a linear objective function subject to a system of linear equality or inequality constraints and non-negativity restrictions.

Graphical Solution Method (Two Decision Variables): When an LPP involves strictly two decision variables (x1,x2), it can be solved geometrically on a two-dimensional Cartesian plane:

- **Plot Constraint Boundaries:** Treat each inequality as a strict equality line (∑aijxj=bi) and plot the line across the x1 and x2 axes.
- **Identify the Feasible Region:** Determine the permissible half-plane satisfying the inequality direction (≤ points toward origin, ≥ points away from origin).
- **Extreme Point (Corner Point) Theorem:** Mathematical linear programming dictates that the optimal solution of an LPP always lies at one of the extreme corner vertices of the feasible region.
- **Evaluate Corner Vertices:** Compute the objective value Z at each corner point coordinate; the vertex yielding the maximum (or minimum) value represents the global optimum.

Special Cases in Linear Programming: For problems involving three or more decision variables, the graphical method fails, necessitating George Dantzig's algebraic Simplex Method:

- **Standard Form Conversion:** Inequalities are converted into strict equalities by adding Slack Variables (si≥0) to ≤ constraints (representing unused capacity) or subtracting Surplus Variables (si≥0) and adding Artificial Variables (Ai≥0) to ≥ constraints (Big-M or Two-Phase Method).
- **Algorithmic Iteration:** Starting from an initial basic feasible solution (usually origin, where real variables are zero and slack variables equal resource capacities), the algorithm computes the net evaluation row (Cj−Zj).
- **Optimality Criterion:** Optimality is reached when all indicators in the net evaluation row are non-positive (Cj−Zj≤0) for maximization problems.

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MODULE II

TRANSPORTATION LOGISTICS ALGORITHMS & ASSIGNMENT OPTIMIZATION

The Transportation Problem Formulation: The standard transportation model considers m manufacturing origins (factories) supplying a homogeneous commodity to n demand destinations (warehouses):

- **Balanced:** A transportation problem is if total factory capacity equals total market demand (∑ai=∑bj).

Methods for Finding an Initial Basic Feasible Solution (IBFS): To initialize the optimization process, three classical heuristics are deployed:

- **North-West Corner Rule (NWCR):** Strictly mechanical allocation starting at cell (1,1) in the upper left corner, fulfilling row supply or column demand sequentially.
- **Least Cost Method (LCM / Matrix Minimum):** Allocates the maximum feasible quantity to the cell possessing the lowest unit transportation cost (cij) across the entire matrix, iteratively eliminating exhausted rows and satisfied columns.
- **Vogel's Approximation Method (VAM):** Computes penalty costs for each row and column (the arithmetic difference between the lowest and next-lowest unit cost in that line).

Optimality Testing: The MODI (Modified Distribution) Method: A basic feasible solution containing exactly m+n−1 independent allocations is tested for optimality via the MODI Method (u−v method):

- Assign dual row values (ui) and column values (vj) such that for every occupied (allocated) cell: ui+vj=cij Setting an arbitrary initial u1=0 allows solving for all remaining ui and vj.
- Compute the opportunity cost (net evaluation) Deltaij for every unoccupied cell: Deltaij=cij−(ui+vj)
- **Optimality Benchmark:** If all Deltaij≥0, the current allocation is globally optimal.

The Assignment Problem and the Hungarian Method: The Assignment Problem optimizes the one-to-one matching of n jobs to n facilities or workers to minimize total completion cost or execution time (xijin0,1).

- **Row Reduction:** Subtract the minimum element in each row from every element in that row.
- **Column Reduction:** Subtract the minimum element in each column from every element in that column.
- **Line Covering Test:** Draw the minimum number of horizontal and vertical lines required to cover all zeros in the reduced matrix.
- **Matrix Modification:** If the line count is less than n, identify the smallest uncovered element (k).
- **Assignment Execution:** Assign jobs to workers starting with rows/columns containing a single zero.

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MODULE III

PROJECT NETWORK SCHEDULING, CPM ALGORITHMS & PERT MODELING

Project Network Architecture and Construction Rules: A project network represents workflow logic utilizing directed graphs:

- **Activity:** A distinct task requiring time and resources, represented by an arrow (→).
- **Event (Node):** The starting or ending milestone of an activity, represented by a circle (igcirc).
- **Precedence Relationships:** Immediate predecessor and successor activities governing technological dependencies.
- **Dummy Activities:** →), utilized strictly to maintain correct precedence logic or prevent two activities from sharing identical starting and ending nodes.

Critical Path Method (CPM): Deterministic Scheduling: CPM applies deterministic time estimates where activity durations are known with high certainty. Network traversal involves two computational sweeps:

- **Forward Pass (Earliest T ×):** Forward Pass (Earliest T ×): Computes the Earliest Start Time (ES) and Earliest Finish Time (EF) by moving from project initiation to completion: EFi=ESi+tiandESj =max(EFpredecessors)
- **Backward Pass (Latest T ×):** Backward Pass (Latest T ×): Computes the Latest Finish Time (LF) and Latest Start Time (LS) by traversing backward from project completion: LSi=LFi−tiandLFi =min(LSsuccessors)
- **Critical Path:** The is the longest contiguous path of interconnected activities connecting project start to finish.

Activity Float (Slack) Metrics

- **Total Float (TF):** TF=LF−EF=LS−ES; Maximum duration an activity can be delayed without delaying overall project completion.
- **Free Float (FF):** FF=ESsuccessor−EF; Delay allowable without delaying the earliest start time of any immediate successor activity.
- **Independent Float (IF):** IF=max(0,ESsuccessor−LFpredecessor−t); Delay allowable under worst-case scheduling conditions without affecting any other activity.

Program Evaluation and Review Technique (PERT): Probabilistic Modeling: S. Navy Polaris missile project, PERT incorporates time uncertainty by utilizing three distinct duration estimates following a Beta Distribution:

- **Optimistic Time (a):** Minimum possible duration assuming optimal operational conditions.
- **Most Likely Time (m):** Modal duration occurring under standard, normal working conditions.
- **Pessimistic Time (b):** Maximum duration assuming adverse delays and complications.

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MODULE IV

GAME THEORY STRATEGIES & DECISION-MAKING UNDER UNCERTAINTY

Foundations of Game Theory: Two-Person Zero-Sum Games: In strategic gaming, a Two-Person Zero-Sum Game represents a competitive conflict where the economic gain achieved by Player A exactly equals the economic loss incurred by Player B (Gain + Loss = 0).

- **Maximin Principle (Player A):** Player A anticipates worst-case payoffs for each strategy row (identifies row minima) and selects the strategy that maximizes these minimum gains (max(Row Minima)).
- **Minimax Principle (Player B):** Player B anticipates worst-case losses for each strategy column (identifies column maxima) and selects the strategy that minimizes these maximum losses (min(Column Maxima)).
- **Row Dominance:** If every element in Row i is less than or equal to the corresponding element in Row k, Row i is strictly dominated and can be deleted (Player A will never choose an inferior payoff).
- **Column Dominance:** If every element in Column j is greater than or equal to the corresponding element in Column m, Column j is strictly dominated and can be deleted (Player B seeks to minimize payouts).

Decision Theory Under Uncertainty and Risk: Decision situations are categorized by the degree of informational certainty: Decision Making Under Certainty (deterministic), Decision Making Under Risk (probabilistic states of nature), and Decision Making Under Uncertainty (probabilities completely unknown).

- **Expected Monetary Value (EMV):** When probabilities (pj) can be assigned to states of nature, decisions are governed by the criterion:
- **Formula (Expected Monetary Value):** EMVi = ∑j=1m pj · Xij
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