Name: Enrolment No:	UPES UNIVERSITY OF TOMORROW

UPES

End Semester Examination, December 2024

Course:	**Semester:**
Program:	**Time : 03 hrs.**
Course Code:	**Max. Marks: 100**
Instructions:	

SECTION A

(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Describe the concept of dominance in Game Theory and its application in economic decision-making.	**4**	**CO1**
Q 2	Explain the concept of strategic form games and provide an example from a network setting.	**4**	**CO1**
Q 3	Define Nash Equilibrium and explain why it may not always exist in pure strategies.	**4**	**CO2**
Q 4	Discuss how correlated equilibria differ from Nash Equilibria with respect to efficiency.	**4**	**CO3**
Q 5	Explain the use of potential games in traffic routing and congestion management.	**4**	**CO3**

SECTION B

(4Qx10M= 40 Marks)

Q 6 — **10** — **CO1**

Using Rationalizability, Analyze Decision-Making in an Uncertain Market Scenario

Consider a two-player game where each player represents a competing firm in an uncertain market. The firms decide to **Invest** (I) in a new technology or **Not Invest** (NI). The payoff table below represents possible outcomes:

	Firm B: Invest (I)	**Firm B: Not Invest (NI)**
Firm A: Invest (I)	(3, 3)	(5, 1)
Firm A: Not Invest (NI)	(1, 5)	(2, 2)

1. Identify the rationalizable strategies for each firm.
2. Discuss the equilibrium outcome based on rationalizable strategies in this uncertain market environment.

Q 7 — **10** — **CO2**

Illustrate with an Example How Supermodular Games Can Be Applied to Study Market Competition

Consider a game with two competing firms (Firm X and Firm Y) choosing their production levels, **High (H)** or **Low (L)**. Assume the payoff is higher for a firm when it matches the competitor's choice, illustrating positive strategic complementarity, a characteristic of supermodular games.

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<table>
<tr><th></th><th>Firm Y: High (H)</th><th>Firm Y: Low (L)</th></tr>
<tr><td>Firm X: High (H)</td><td>(4, 4)</td><td>(2, 3)</td></tr>
<tr><td>Firm X: Low (L)</td><td>(3, 2)</td><td>(5, 5)</td></tr>
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Show that this is a supermodular game by demonstrating that payoffs increase as both firms move from (L, L) to (H, H).
Discuss how the firms’ decisions align in equilibrium due to strategic complementarity.

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<td>Q 8</td>
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Apply Backward Induction to Solve an Extensive Form Game in a Competitive Bidding Context
Consider an auction with two bidders, Bidder A and Bidder B, competing for an asset with an initial value of $50. The game proceeds as follows:

Stage 1: Bidder A chooses a bid level: High (H) or Low (L).
Stage 2: Bidder B observes A’s choice and chooses to Match or Not Match the bid.

The payoffs for each possible outcome are:

If both choose High (H), the winner’s payoff is $40, and the loser’s payoff is $0.
If both choose Low (L), the winner’s payoff is $30, and the loser’s payoff is $10.
If one chooses High (H) and the other chooses Low (L), the higher bidder wins with a payoff of $50, and the lower bidder gets $0.
Construct the game tree.
Apply backward induction to find the optimal strategies for Bidder A and Bidder B.

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<td>CO3</td>
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<td>Q 9</td>
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Compare Subgame Perfect Equilibrium with Nash Equilibrium in Terms of Strategy Predictability
Consider a sequential-move game where Player 1 chooses A or B, followed by Player 2 observing the choice and choosing C or D. The payoffs are as follows:
<table>
<tr><th></th><th>Player 2: C</th><th>Player 2: D</th></tr>
<tr><td>Player 1: A</td><td>(2, 3)</td><td>(4, 1)</td></tr>
<tr><td>Player 1: B</td><td>(3, 2)</td><td>(1, 4)</td></tr>
</table>

Identify the Nash Equilibria of the game.
Use subgame perfect equilibrium to determine the outcome in each subgame.
Compare the predictability of strategies in Nash and subgame perfect equilibria, explaining how the sequential nature of the game influences the players' strategies.

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<td>CO4</td>
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SECTION-C

(2Qx20M=40 Marks)

Q 10

Bayesian Game in an Auction Scenario

Background: Two bidders, Bidder A and Bidder B, are participating in a sealed-bid auction for a rare item. Each bidder's valuation of the item, vA and vB, is private information and independently drawn from a common distribution. The bidders only know their own valuation but have a belief about the possible valuation of the other.

Scenario: Each bidder can choose to bid **High (H)** or **Low (L)**. If both bid low, neither wins the item. If both bid high, there's a tie, and the item is awarded based on a coin flip. If one bids high and the other bids low, the higher bidder wins the item.

Payoff Structure: The payoff for winning is the difference between the item's value to the bidder and the amount paid. If no one wins, the payoff is zero.

	Bidder B: High (H), vB=8	**Bidder B: Low (L), vB=8**
Bidder A: High (H), vA=10	(1, 0) if won, (0, 1) if lost	(2, 0)
Bidder A: Low (L), vA=10	(0, 4)	(0, 0)

Question:

1. Formulate the game as a Bayesian game, identifying the players' strategies, types, and payoffs.
2. Discuss how a Bayesian Nash Equilibrium can optimize each bidder's strategy, considering the uncertainty in the opponent's valuation.
3. Analyze how each bidder's strategy might change if they have differing beliefs about the other's valuation distribution.

20 **CO3**

Q 11

Mechanism Design for Multi-Agent Contracting

Background: A company is looking to design a contract for multiple contractors (Agent 1 and Agent 2) to deliver services. Each agent has private information about their cost of service, either **High (H)** or **Low (L)**. The company wants to maximize service quality while minimizing costs but doesn't know each agent's cost.

Scenario: The contract can be structured in two ways: **Incentive-Based** (IB) or **Flat-Rate** (FR). The effectiveness of each contract type depends on the agents' true costs, with higher incentives leading to better quality but at a higher cost for the company.

Payoff Structure: The table below shows payoffs for the company and agents under each contract type and cost scenario.

	Agent 2: High Cost (H)	**Agent 2: Low Cost (L)**
Agent 1: High Cost (H), FR	(5, 5)	(6, 3)

20 **CO5**

Agent 1: High Cost (H), IB	(8, 6)	(9, 4)
Agent 1: Low Cost (L), FR	(6, 2)	(10, 10)
Agent 1: Low Cost (L), IB	(7, 4)	(12, 8)

Question:

1. Analyze the game and determine how mechanism design principles can be applied to create a contract that aligns the agents' incentives with the company's objectives.
2. Evaluate which contract structure (IB or FR) would be more effective for the company, considering the agents' private cost information.
3. Discuss the limitations of using mechanism design in such settings, particularly when agents may misreport their costs.