

JK Lakshmipat University Jaipur
INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination, Dec. 2023 (Open Book)

B. Tech. All branches, Semester VII (OE)

Roll No.....

EE-1223: Computational Game Theory and Applications

Time: 2 hrs 30 Min

Max. Marks: 40

Instructions to students:

1. Do not write anything other than your roll number on the question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Attempt all questions.

Q-1	In a two-player game, define Nash Equilibrium. Discuss the conditions for a dominant strategy. Provide an example and calculate Nash Equilibrium if applicable.	04 Marks (CO-1)																							
Q-2	Calculate the Nash Equilibrium for a simplified oligopoly game involving three firms. Provide the payoff matrix and discuss the strategic interactions among the firms.	04 Marks (CO-2)																							
Q-3	Consider a two-player game with the following payoff matrix: <table><tr><td></td><td>Player 1 Swerves</td><td>Player 1 Straight</td></tr><tr><td>Player 1 Swerves</td><td>(3, 3)</td><td>(0, 4)</td></tr><tr><td>Player 1 Straight</td><td>(4, 0)</td><td>(-1, -1)</td></tr></table> Calculate the Nash Equilibrium for this game.		Player 1 Swerves	Player 1 Straight	Player 1 Swerves	(3, 3)	(0, 4)	Player 1 Straight	(4, 0)	(-1, -1)	04 Marks (CO-2)														
	Player 1 Swerves	Player 1 Straight																							
Player 1 Swerves	(3, 3)	(0, 4)																							
Player 1 Straight	(4, 0)	(-1, -1)																							
Q-4	In a rock-paper-scissors game, Player 1 chooses rock (R), paper (P), or scissors (S), and Player 2 makes the same choices. The payoff matrix is as follows: <table><tr><td></td><td></td><td colspan="3">Player-2</td></tr><tr><td></td><td></td><td>R</td><td>P</td><td>S</td></tr><tr><td rowspan="3">Player-1</td><td>R</td><td>(0, 0)</td><td>(-1, 1)</td><td>(1, -1)</td></tr><tr><td>P</td><td>(1, -1)</td><td>(0, 0)</td><td>(-1, 1)</td></tr><tr><td>S</td><td>(-1, 1)</td><td>(1, -1)</td><td>(0, 0)</td></tr></table> Determine the mixed strategy Nash Equilibrium for this game.			Player-2					R	P	S	Player-1	R	(0, 0)	(-1, 1)	(1, -1)	P	(1, -1)	(0, 0)	(-1, 1)	S	(-1, 1)	(1, -1)	(0, 0)	04 Marks (CO-2)
		Player-2																							
		R	P	S																					
Player-1	R	(0, 0)	(-1, 1)	(1, -1)																					
	P	(1, -1)	(0, 0)	(-1, 1)																					
	S	(-1, 1)	(1, -1)	(0, 0)																					
Q-5	Consider a Bayesian game where Player 1 has private information I (high or low). Player 2 observes I and takes an action accordingly. The payoff matrix is: <table><tr><td></td><td>Player 2 A</td><td>Player 2 B</td></tr><tr><td>Player 1 High</td><td>(5, 2)</td><td>(1, 4)</td></tr><tr><td>Player 1 Low</td><td>(3, 1)</td><td>(2, 3)</td></tr></table> Calculate the Bayesian Nash Equilibrium for this game.		Player 2 A	Player 2 B	Player 1 High	(5, 2)	(1, 4)	Player 1 Low	(3, 1)	(2, 3)	04 Marks (CO-5)														
	Player 2 A	Player 2 B																							
Player 1 High	(5, 2)	(1, 4)																							
Player 1 Low	(3, 1)	(2, 3)																							
Q-6	Three players, A, B, and C, collaborate on a project with total earnings of \$1000. The Shapley values for A, B, and C are calculated as follows: <table><tr><td>$v(\{A\})=20$</td><td>$v(\{A,B\})=60$</td><td>$v(\{A,B,C\})=100$</td></tr><tr><td>$v(\{B\})=30$</td><td>$v(\{A,C\})=40$</td><td></td></tr><tr><td>$v(\{C\})=15$</td><td>$v(\{B,C\})=50$</td><td></td></tr></table> Calculate the Shapley value for each player.	$v(\{A\})=20$	$v(\{A,B\})=60$	$v(\{A,B,C\})=100$	$v(\{B\})=30$	$v(\{A,C\})=40$		$v(\{C\})=15$	$v(\{B,C\})=50$		06 Marks (CO-4)														
$v(\{A\})=20$	$v(\{A,B\})=60$	$v(\{A,B,C\})=100$																							
$v(\{B\})=30$	$v(\{A,C\})=40$																								
$v(\{C\})=15$	$v(\{B,C\})=50$																								

Q-7 Case Study	Consider a city where multiple electric vehicle (EV) charging stations are operated by different companies. Each company must decide on its pricing strategy for EV charging to maximize profits while considering the competition. Scenario: Company A and Company B operate EV charging stations in the same neighborhood. The charging price set by one company affects the customer choices and, consequently, the revenue of the other. The payoff matrix is given below: <table><tr><td></td><td>Company B Low Price</td><td>Company B High Price</td></tr><tr><td>Company A Low Price</td><td>(10, 8)</td><td>(5, 5)</td></tr><tr><td>Company B High Price</td><td>(6, 10)</td><td>(8, 6)</td></tr></table> Question: Analyze the EV charging game between Company A and Company B. Determine the Nash Equilibrium and discuss the strategic considerations for both companies. How does pricing affect their profits and market share?		Company B Low Price	Company B High Price	Company A Low Price	(10, 8)	(5, 5)	Company B High Price	(6, 10)	(8, 6)	07 Marks (CO-4)							
	Company B Low Price	Company B High Price																
Company A Low Price	(10, 8)	(5, 5)																
Company B High Price	(6, 10)	(8, 6)																
Q-8 Case Study	Consider a smart grid system where multiple energy producers (Companies X, Y, and Z) supply electricity to a common grid. The grid operator must decide on the power distribution strategy while considering the cost implications and cooperation among producers. Scenario: Companies X, Y, and Z produce electricity and submit their power distribution plans to the grid operator. The payoff matrix, representing the cost of each distribution plan and resulting profit for each company, is as follows: <table><tr><td></td><td>X's Plan</td><td>Y's Plan</td><td>Z's Plan</td></tr><tr><td>Grid Operator Plan A</td><td>(5, 4, 6)</td><td>(7, 3, 5)</td><td>(6, 5, 4)</td></tr><tr><td>Grid Operator Plan B</td><td>(4, 6, 5)</td><td>(5, 5, 5)</td><td>(3, 7, 4)</td></tr><tr><td>Grid Operator Plan C</td><td>(6, 5, 4)</td><td>(4, 7, 3)</td><td>(5, 4, 6)</td></tr></table> Question: Examine the cooperative game among Companies X, Y, and Z and the grid operator. Determine the core of this cooperative game and discuss the stability of the suggested power distribution plans. How can cooperative strategies benefit both the companies and the grid operator?		X's Plan	Y's Plan	Z's Plan	Grid Operator Plan A	(5, 4, 6)	(7, 3, 5)	(6, 5, 4)	Grid Operator Plan B	(4, 6, 5)	(5, 5, 5)	(3, 7, 4)	Grid Operator Plan C	(6, 5, 4)	(4, 7, 3)	(5, 4, 6)	07 Marks (CO-3)
	X's Plan	Y's Plan	Z's Plan															
Grid Operator Plan A	(5, 4, 6)	(7, 3, 5)	(6, 5, 4)															
Grid Operator Plan B	(4, 6, 5)	(5, 5, 5)	(3, 7, 4)															
Grid Operator Plan C	(6, 5, 4)	(4, 7, 3)	(5, 4, 6)															