19. GAME THEORY

Q:1 Explain the basic Concepts of Game Theory ?

(A) Introduction :- Game theory is a field of study that investigates Modelling and solution techniques For decision making Situations where strategic interaction between Rational Players affect the Out come. Game theory is Useful in Various areas like - Pricing, Law, auctions, biology, War strategy, artificial intelligence etc.

(B) Basic Concepts of Game Theory :-

1. Players
2. Strategies
3. Pay OFF

Any game has three basic concepts like -

1] Players :- The Players are the decision makers Whose tries to explain and Predict strategies of firm.

Example :- Managers of Oligopolistic firms are the decision makers of market strategies.

2] Strategies :- Strategies are the Potential Choices available to the Players.

Example :- Selection of Price Policy, to develop new or differentiated Products, New Techniques of Advertisement to increase Production Capacity etc. These strategies affect the Sales and Profitability of Firm.

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3] **Payoff :-** " The Pay off is the Outcome or Result of each Strategy "

The Payoff is Generally expressed in terms of Profits or Losses of the final firm which are the result or Outcome due to strategies implemented by firms. Each Producer Prepare Payoff matrixs to know Possible Combination of Strategies.

Pay off Matrix / Table helps every Producer to know Outcome for each Possible Combination OF Strategies Open to the firm and the Rival's Responses.

© **Example :- A Pay-OFF Matrix for a Price War**

		Firm – A	
		Normal Price	Price War
Firm B	Normal Price	A ₹10 ₹10	B -₹100 -₹10
	Price War	C -₹10 -₹100	D -₹50 -₹50

1) Firm A and Firm B each take Two decision regarding Normal Price and Price War. It means we get four Possible Outcomes – A, B, C and D.

2) In A-Outcome both firm A and B choose Normal Price. Lower-Left is Pay-OFF of firm B and Upper-Right is Pay-OFF of firm-A.

3) In D-Outcome both firm A and B choose Price War of ₹50.

4) But B and C options shows that one firm select Normal Price and other firm choose Price War.

Q:2 Analyse the Strategic decisions by using Game Theory?
OR Write short Note on Dominant Strategy
OR Short Note on Nash Ecouilibrium.

(A) Strategic Decision Using Game Theory:-

Game theory can be used to analyse not only your own actions but also the interactions between your goals and responds of rivals.

(B) Example:- Pay-OFF Matrix

		Firm A	
		Normal Price	Price War
Firm B	Normal Price	A ₹10 ₹10	B -₹100 -₹10
	Price War	C -₹10 -₹100	D -₹50 -₹50

There Four alternative Strategies given in the above Pay-OFF Matrix table.

1] Both firms A and B are following the Strategy of Normal Price - ₹10. So both enjoy highest Joint Profits.

2] Both Firms A and B adopt the Strategy of Price-War and try to reduce price by ₹50 and suffer huge Lossess. i.e - D Option.

3] Firm-B adopt Price War by reducing Price of ₹100 and Firm-A adopt to reduce Price by ₹10. Here Firm B

get Large Share in the market but suffer heavy Losses but firm-A is in better financial position.

4) Similarly firm-A adopt Price War by reducing Price of ₹ 100 and firm-B adopt Normal Price. Here firm A get Large Share in market but suffer heavy Losses but firm-B is in better position.

© Dominant Strategy :-

The most Simplest Strategy is dominant Strategy. Here one player adopt Simple best Strategy Without Considering the Strategy adopted by other players in market.

"A Player has a dominant Strategy when that Strategy Provides a higher Pay OFF without considering the strategy adopted by other Players in market"

As it is Observed in above example →
If both firms adopt Normal Price of ₹ 10 then both will Jointly earn highest Profits. But if one firm adopt Normal Price and other declare Price-War then Firm adopting Normal Price will earn Profits but Firm declaring Price War will suffer huge Losses. Thus Charging Normal Price is the Dominant Strategy. When both firms are following Dominant Strategy they achieve dominant equilibrium with higher Profits.

(D) Nash Equilibrium :-

The concept of Nash Equilibrium was developed by John Nash - the mathematician who won a Noble Prize for his discovery.

"Nash Equilibrium means any combination of Strategies in which in which each player's strategy is his best choice as compare to other player's Choice"

Nash Equilibrium is the Situation where each player Select a Optimal Strategy as compare to the strategy Choosen by other player.

(E) Example - Pay-OFF Matrix of Rivalry Game

		Firm - A	
		High Price	Normal Price
Firm B	High Price	A ₹100 ₹200	B -₹20 ₹150
	Normal Price	C ₹150 -₹30	D ₹10 ₹10

1] Both Firms enjoy Normal Price Equilibrium when they adopt dominant Strategy in Cell-D. Both Firm get Profit of ₹ 10.

2] When Both Firms Collude with each other then they Can set High Price like monopoly shown in Cell-A.

3] In Cell-B, Firm-B Follows, High Price Strategy and

firm-A follows Normal Price strategy. Under this situation, firm-A makes Profit of ₹ 150, and firm-B incur a Loss of ₹ 20.

4) In Cell-C firm-A follows High Price strategy and firm-B follows Normal Price strategy. Under this situation firm-A incur the Loss of ₹ 30 and Firm-B earn Profit of ₹ 150.

3) We Observed that firm-B has dominant strategy in this game. firm-B can earn higher Profits by Choosing Normal Price.

4) firm-A has to depend on firm-B for Choosing Price Policy. If firm-B select High Price, firm-A also select High Price. If firm-B select Normal Price, firm-A also select normal Price to earn Profit.

Thus firm-A is dilemma which has no dominant Strategy.

Therefore Optimal Strategy for firm-A to adopt Normal Price. This is called Nash Equilibrium Shown in Cell-D.

In a Nash Equilibrium, No players can earn Profits by Changing his own strategy. The Nash Equilibrium is also called the Non Co-operative Equilibrium because each Party Chooses the Strategy which is best for himself.

Q:3 Explain the Concept of Prisoner's Dilemma. How it is applied in Oligopolistic Pricing Problem?

(A) Prisoner's Dilemma :-

Prisoner's Dilemma is a game in which each player has a dominant Strategy, and when each plays it, the resulting Payoffs are smaller than if each had played a dominant strategy.

The Prisoner's dilemma is a Paradox in decision-analysis in which two individuals acting in their own self-interests do not produce Optimal Outcome. Generally Oligopolistic firms Often face the Problem of Prisoner's dilemma.

(B) Example :-

The Prisoner's dilemma is a Situation where two parties are separated and Unable to communicate. Each party may or may not Choose to Co-operate. But they enjoy highest reward when both parties Choose to Co-operate.

Example :- Two members of bank Robbers have been arrested and are being interrogated in Separate rooms.

Police do not have other witnesses, if they can Convince at least one of the robbers to betray accomplice and Confess his Crime then he/she will go free.

If Suspect Person do not Confess it then they will

receive a full ten-years punishment in Jail. If both Robbers/Suspect confess then their Punishment will reduce to 5 years.

		Robber/Suspect - B	
		Confess	Not Confess
Robber/ Suspect - A	Confess	5, 5 yrs	0, 10 years
	Not Confess	10, 0 yrs	1, 1 years

In above example there are four outcomes —

1) When both Suspects/Robbers are Confessing then it is best/dominant strategy both will get Punishment for 5 years.
2] IF Suspect A Confess but B donot confess the Crime then Suspect-A will set Free and Suspect-B will get 10 years Punishment.
3] IF Suspect A donot confess but A Confess the Crime then suspect A will given Punishment of 10 years and suspect-B will be Free.
4) But when both do not Confess the Crime then both will be given Punishment of One year As it is not Possible For the suspects to Communicate in Jail, each suspect will try to adopt dominant strategy to get 5 years Punishment

© **Application of Prisoner's Dilemma in Oligopoly Market :-** The Concept of Prisoner's

dilemma is mostly useful in Oligopoly market

Example:- Pay-OFF Matrix for a Pricing Game

		Firm-B	
		Low Price (Cheat)	High Price (don't cheat)
Firm A	Low Price - cheat	A - 2, 2	B - 5, 1
	High Price - don't cheat	C - 1, 5	D - 3, 3

1) When Firm A and Firm-B follows Low price then both will able to earn ₹ 2 Profit. → A Cell

2) IF Firm-A follows Low Price but Firm B Follows High Price then Firm gets higher Profit of 5 and Firm B gets Smaller Profit of ₹1. → B cell.

3) Similarly when Firm A follows High Price Policy then it can earn Profit of ₹ 1 but here Firm-B adopt Low Price so it can earn Profit of ₹ 5 → C Cell

4) But When both firms adopt High Price Policy by Colluding and Co-operating each other then both get the Profit of ₹3. → D Cell

Thus Firms are in Prisoner's dilemma. When Firms are Charging Low price they earn Smaller Profits. When Firms are Charging High Price they earn Larger Profits

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Q:4 Choose the Correct answer and rewrite the Statements:-

1.) Which theory has numerous applications ? Game

a) Game b) monopoly c) Oligopoly.

2) Game theory is concerned with the choice of an Optimal Strategy in Which Situation? Conflict

a) Non-Conflict b) Conflict c) fighting.

3) Who are the decision-makers in game theory ?

Players

a) Players b) Consumers c) Producers

4) What are the Potential Choices available to the Players?

Strategies

a) Alternatives b) strategies c) Profits

5) A dominant strategy is one that Produces Higher Pay-off no matter what the other Players in a game choose.

a) Higher b) Lower c) minimum.

6) A game is said to be in which equilibrium if each Player's strategy is the best he can choose, given the other Players choices. Nash

a) Dominant b) Nash c) Pareto.

Q:5 State Whether the Following statements are True or false giving reasons :-

1. Game Theory has applications only in Economics.

Ans: False. Reasons:- Q:1 - A Part

2) Game theory is Concerned with the Choice of a Optimal strategy in Conflict Situation.

Ans:- True. Reasons:- Game theory was introduced by John Von Neumann and Oskar Morgenstern in their book — "Theory of Games and Economic behaviour" in 1944. Game theory is related with the Choice of an optimal Strategy in Conflict Situations. It is more helpful to oligopolist to Choose a Course of action.

Example - The best Price to Charge without having Price-War.

3) Players are the Participants in the Game Theory.

Ans:- False. Reasons:- Q:1 - B-Part - 1st Point

4) Strategies are the Potential Choices available to the Consumers.

Ans:- False. Reasons:- Q:1 - B-Part - 2nd Point

5) Pay-OFF is the Outcome of each Strategy in a Game Theory.

Ans:- True Reasons:- Q:1- B-Part - 3rd Point

6) Nash Equilibrium is a Situation in which each Player Chooses non-Optimal strategy, given the strategy Choosen by other Players?

Ans:- False Reasons:- Q:2 - D Part.