**MAYANJA MEDDIE**

**23/2/306/D/339**

**Summary of Computational Game Theory**

Game theory is about how people, companies, or organizations make decisions when their choices affect each other. It assumes that players are rational, meaning they try to get the best result (utility) within their limits, like money, time, or information. These results are measured as payoffs, which show how satisfied or successful a player is with an outcome.

One key idea is the Nash Equilibrium. This is when no player can do better by changing their choice alone. It explains why some situations stay stable, even if they are not the best for everyone. For example, in the Prisoner’s Dilemma, both players confess because it’s safer, even though staying silent together would give a better outcome. Game theory also separates **non-**cooperative games (players act alone for self-interest) and cooperative games (players work together and share rewards fairly, like with the Shapley Value).

In markets, balance happens when supply equals demand. This is called market equilibrium. Mechanism design (reverse game theory) creates rules that make people’s personal goals match society’s goals. A good example is auctions, where items are sold based on bids. There are different types: first-price, second-price (Vickrey), English, and Dutch. The second-price auction is special because it encourages people to tell the truth about how much they value an item. Another concept is the Price of Anarchy, which shows how systems lose efficiency when everyone acts selfishly like in traffic jams or internet routing.

Incentives guide how people act. If systems are designed well, it is best for players to tell the truth (incentive compatibility). Problems can occur, such as the principal agent problem, where a worker (agent) may not act in the best interest of the boss (principal). Other issues include moralhazard (hidden risky behaviour after a deal) and adverse selection (hiding important information before a deal). Solutions include contracts, reputation systems, and signals (like degrees, ratings, or certifications) that show credibility.

Efficiency and fairness also matter. Pareto efficiency means no one can be made better off without hurting someone else, though it may not always be fair. Economists use social welfarefunctions to judge fairness utilitarian (total happiness), egalitarian (focus on the worst off), or Nash product (balance of fairness and efficiency). In practice, finding the best solution can be hard because many problems are computationally complex **(**NP-hard). That’s why approximation methods and algorithms are used. Fair division problems, like splitting a cake or assigning schools, show the challenge of making things both fair and efficient.

In short, computational game theory explains how people and systems act when choices are connected. It helps us understand behaviour in markets, design fair and efficient systems, and balance personal goals with social good. These ideas are useful in economics, technology, and daily decision-making.