CS 827 Applied Game Theory			
Credit Hours:	3+0	**Prerequisites:**	None

Course Objectives:

This course introduces its audience to the fundamentals of the applied Game Theory. Game Theory is a mathematical framework which makes possible analysis of the decision-making process of the interdependent subjects. It is aimed at explaining and predicting how individuals/agents/processes behave in a specific strategic situation, and therefore help improve decision making. A situation is strategic if the outcome of a decision problem depends on the choices of more than one agent. Most decision problems in real life are strategic. The course will cover in depth the fundamental concepts: representing games and strategies in normal form, extensive form games, repeated games, non-cooperative & cooperative games, perfect and imperfect information games, complete & incomplete information games, Bayesian games, multiagent reinforcement learning, and standard equilibrium concepts (such as Nash Equilibrium, Subgame-Perfect Nash Equilibrium, and others) in Game Theory. To illustrate the concepts, real-world examples, case studies and research papers from various domains of computer science will be used.

Course Contents:

- Introduction to Game Theory and its applications to real-world and computing domain problems
- Formal definition of a Game: the normal form, players, actions, payoffs, strategies, dominant strategies; Normal Form Games: Pure strategy Nash Equilibrium, zero-sum games, general-sum games
- Mixed Strategy Nash Equilibrium; Alternate Solution Concepts: Iterative removal of strictly dominated strategies, minimax strategies and the minimax theorem for zero-sum game, correlated equilibria
- Extensive Form Games: Perfect information games: trees, players assigned to nodes, payoffs, backward Induction, subgame perfect equilibrium, introduction to imperfect-information games, mixed versus behavioral strategies; Repeated Games: Repeated prisoners dilemma, finite and infinite repeated games, Future-discounted reward; Multiagent Reinforcement Learning: Stochastic Games, Q-learning
- Incomplete Information Games: Signaling games, Bayesian games, applications of Bayesian games
- Coalitional Games: Transferable utility cooperative games, Shapley value, Core, applications
- Mechanism Design

Course Learning Outcomes:

At the end of the course the students will be able to:

1. Identify strategic situations and understand the key concepts of preferences, utility, and decision-making
2. Understand and be able to apply the key models and solution concepts of non-cooperative game theory
3. Understand and be able to apply the key models and solution concepts of

cooperative game theory
4. Identify, understand, and be able to apply game theory concepts to various research problems of computer science domain

Teaching Methodology:

Lectures, Problem based learning

Course Assessment:

Sessional Exam, Home Assignments, Quizzes, Project, Presentations, Final Exam

Reference Materials/ Books:

1. Essentials of Game Theory, by Kevin Leyton-Brown and Yoav Shoham; Morgan and Claypool Publishers, 2008
2. Game Theory by Drew Fundenberg, MIT Press, 2011
3. Multiagent Systems: Algorithmic, Game-Theoretic and Logical Foundations, by Yoav Shoham and Kevin Leyton-Brown, Cambridge University Press, 2008.