ECE4172(S) : Game Theory in Wireless Communication Networks

Programme: B.Tech. ECE   **Year:** 4th   **Semester :** Even
Course Type: Programme Elective   **Credits:** 3   **Hours :** 40

Course Context and Overview (100 words):
In the last two decade Wireless Communication has experienced a massive growth in traffic demand. To support the ever increasing demand along with requirement to meet QoE ,QoS, regulatory requirement and to able to score better in benchmark performance metrics, the wireless industry faced the problem of multi-objective resource optimization. Game Theory can be one solution to such problems. It can characterize, model, analyze, design various issues in wireless communication in particular resource allocation, interference mitigation energy saving etc.

Prerequisites Courses: Digital Communication, Computer Network

Course outcomes(COs):

On completion of this course, the students will be able
CO1: to understand and apply various game theory models that can be applied to cooperative and non-cooperative wireless communication systems.
CO2: to understand application in Canonical Coalition game, Potential game and Distributive learning of Equilibrium concepts in wireless communication network
CO3: to analyze radio uplink power control and down link power allocation, resource allocation and coverage optimization problem in emerging heterogeneous small cell networks.
CO4: to understand game theory applications in physical layer security, infrastructure sharing, and green communication aspects of wireless communication networks.

Course Topics:

Topics	Lecture Hours	
UNIT - I **1. Basic Concepts of Game Theory**	**17**	
1.1 Introduction and need for Game theory in Wireless Communication Networks.	1	
1.2 Non-Cooperative games-introduction and basic concepts	2	
1.3 Matrix games , Dominating strategies ,Nash equilibrium, Static continuous-kernel games, Mixed strategies, Efficiency and equilibrium selection	3	
1.4 Dynamic non-cooperative games-Non-cooperative games in extensive form, Repeated games, Stochastic games	2	
1.5 Special classes of non-cooperative games, Potential games, Stackelberg games , Correlated equilibrium, Super modular games, Wardrop equilibrium	3	
1.6 Bayesian games -Static Bayesian game, Bayesian dynamic games in extensive form, Cournot duopoly model with incomplete information, Auction with incomplete information	2	

1.7 **Cooperative games** -Bargaining theory, The Nash bargaining solution, Sample applications in wireless and communication networks, Coalitional game theory: basics, Class I: canonical coalitional games ,Main properties of canonical coalitional games, The Shapley value, Class II: coalition-formation games ,Impact of a coalitional structure on solution concepts for canonical coalitional games, Class III: coalitional graph games- Coalitional graph games and network-formation games.	4	
UNIT - II 2. **Game theory applications in Wireless Communication Network-I**	**8**	
2.1 Sample application of Canonical Coalition game of class I, class II and class III	4	
2.2 Potential game and its applications to wireless networks	2	
2.3 Distributive leaning of equilibrium with incomplete and dynamic information	2	
UNIT-III 3. **Game theory applications in Wireless Communication Network-II**	**8**	
3.1 Game Theory approaches in Heterogeneous Networks	2	
3.2 Interference mitigation with Power Control and allocation	2	
3.3 Game theory based radio resource optimization	2	
3.4 Game theory based coverage Optimization	2	
UNIT-IV 4. **Game Theory for Wireless Techniques and services**	**7**	
4.1 Game theory for Physical Layer security	1	
4.2 Game theory for Infrastructure sharing in cellular network	2	
4.3 Game theory framework for cooperative content sharing	2	
4.4 Game theory for Green HetNet	2	

Text Books:
[1] Zhu Han, Dusit Niyato, Walid Saad, Tamer Başar and Are Hjørungnes, "Game Theory in Wireless and Communication Networks: Theory, Models, and Applications, Cambridge University Press, 2011, ISBN: 9780521196963
[2] Yang, Chungang, and Jiandong Li. "Game Theory Framework Applied to Wireless Communication Networks." IGI Global, 2016. 1-502, doi:10.4018/978-1-4666-8642-7

Reference book:
Yan Zhang, Mohsen Guizani, "Game Theory for Wireless Communications and Networking", CRC Press 1st Ed.,Sept,2019,1 - 585, ISBN 9780367382599 - CAT# K450175

Additional Resources (Web resources etc.):
 An Introduction to Game Theory, By Prof. Prof. Aditya K. Jagannatham , IIT Kanpur
https://nptel.ac.in/courses/110104063/

Evaluation Methods:

Item	Weightage (%)
Assignments/Term paper	30
Mid Term	20
End Term	50

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