Course Syllabus-Winter 2026 (Semester 252)

Department of Mathematics

KFUPM

Math 407-Applied Game Theory

Dr. Slim Belhaiza

Description:

Formulation of strategic and cooperative games in the energy industry, such as oil & gas and electric power companies, and portfolio analysis. Dominant, optimal strategies and Nash equilibrium. Coalition formation in cooperative games is used to represent energy conflicts and investigate their formation. Games in characteristic function format. Concepts of solutions for games. Pareto optimal solutions, core, and Shapley value. Other cases on resource allocation, design, and supply chain will be studied.

Reading Material:

- Main Text Book: G. Owen, Game Theory, 4rd Edition, AP, 2013.

- Reference Text Book

- Game Theory: Analysis of Conflict, Roger B. Myerson, 1997, Harvard University Press.

- Game Theory, D. Fudenberg and J. Tirole, 1991, MIT Press.

- Chapter 5: Game Theory and Applications, S.J. Belhaiza, Book Draft, In Progress, 2023.

Prerequisite: ISE 303 or Stat 361.

It is required that students attending the course be familiar with linear algebra and linear and nonlinear programming.

Course Objectives:

1. Introduce the student to game theory and strategic decision-making in conflicting and/or cooperative environments
2. Cover various game-theoretic modelling, equilibrium concepts, and the solution computations
3. Introduce the student to a variety of real-world applications of game theory in decision-making for the energy industry at large.

Content

Course Chapter	Textbook Chapter	Nbr of Hours
1. Introduction to Game Theory. - Rationality. - Utility maximization. - Applications.	**[Chapters 1- 2]**	**(3 hours)**
2. Basic Models. - Games in Extensive Forms. - Strategic form games and Normal representation. - Domination and reduced normal representation. - Applications.	**[Chapters 1-2]**	**(6 hours)**
3. Equilibria of Strategic-Form Games. - Nash Equilibrium. - Computing Nash Equilibria. - Applications.	**[Chapters 1-2-3]**	**(9 hours)**
4. Sequential Equilibria of Extensive Games. - Sequential Rationality. - Computing Sequential Equilibria. - Subgame-Perfect Equilibria. - Applications.	**[Chapters 1-2-3]**	**(9 hours)**
5. Refinements of Nash equilibrium - Perfect Equilibria. - Proper Equilibria. - Correlated Equilibria. - Applications.	**[Chapters 1-2-3-8]**	**(9 hours)**
6. Repeated Games. - General Model of Repeated Games. - Repeated Games with Standard Information. - Repeated Games with Incomplete Information. - Applications.	**To be announced…**	**(6 hours)**
7. Evolutionary Games	**To be announced…**	**(3 hours)**

Grading Policy:

- **Homeworks: 25%**
- **Midterm exam: 25%.**
- **Term Paper+Presentation: 10%+10% = 20%.**
- **Final Exam: 30%.**

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Attendance: A DN grade will be awarded to any student who accumulates 10 unexcused absences or more.