GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2020-2021

Game Theory with Engineering Applications (E003700)

Due to Covid 19, the education and evaluation methods may vary from the information displayed in the schedules and course details. Any changes will be communicated on Ufora.

Course size (nominal values; actual values may depend on programme)

Credits	6.0	Study time	180 h	Contact hrs	60.0 h

Course offerings and teaching methods in academic year 2020-2021

A (semester 1)	English	Gent	lecture	30.0 h
			seminar: coached exercises	30.0 h

Lecturers in academic year 2020-2021

Steendam, Heidi	TW07	lecturer-in-charge
Fiems, Dieter	TW07	co-lecturer

Offered in the following programmes in 2020-2021	crdts	offering
Bridging Programme Master of Science in Industrial Engineering and Operations Research	6	A
Bridging Programme Master of Science in Industrial Engineering and Operations Research	6	A
Master of Science in Electrical Engineering (main subject Communication and Information Technology)	6	A
Master of Science in Electrical Engineering (main subject Electronic Circuits and Systems)	6	A
Master of Science in Industrial Engineering and Operations Research	6	A
Master of Science in Computer Science Engineering	6	A
Master of Science in Computer Science Engineering	6	A
Master of Science in Industrial Engineering and Operations Research	6	A

Teaching languages

English

Keywords

Game theory

Position of the course

Game theory studies decision making by several distinct entities, each having their individual and often conflicting objectives. This course introduces the concepts of game theory applied to various engineering problems where the overall system dynamics follow from the actions of multiple decision makers. Prime engineering examples include flow control where decision makers adapt their demand to possible congestion, routing decisions in networks, where decision makers look for the best route through a network, and power control where decision makers make a trade-off between the power needed for and the success of an operation (like a transmission over a wireless channel).

Contents

- **Introduction:** Game theory and mechanism design for engineering applications; medium access control problems; routing problems; resource allocation problems.
- **Static non-cooperative games**: Matrix games and continuous-kernel games; Dominating strategies; Nash Equilibrium; Price of anarchy; Price of stability; Mixed and correlated equilibria; Computation of Nash equilibrium in matrix games. Multiple resource congestion game.
- **Dynamic non-cooperative games**: Extensive form games with imperfect information: normal form, subgame perfect equilibrium, sequential equilibria;

Multistage games with observed actions; Repeated games; Stackelberg games; Relay selection and power control game.
- **Evolutionary games:** Evolutionary stable strategies; Replicator dynamics; Hawk-dove game; Evolutionary games for the Aloha protocol and for peer-to-peer networking.
- **Games with incomplete information:** Mixed and behavioural strategies. Bayesian Nash equilibrium. Applications in auctions. Different auction formats. Revenue and efficiency properties of different auctions.
- **Mechanism design:** Optimal auctions; Revelation principle. Implementability; Revenue-equivalence theorem; Vickrey–Clarke–Groves mechanisms; Mechanisms in networking, decentralized mechanisms.
- **Cooperative games**: Coalitions; Monotone games; Superadditive games; Convex games; Core of the game; Shapley value.

Initial competences

Basic probability theory and statistics; basic real analysis.

Final competences

1 Master the formulation and mathematical solution techniques of non-cooperative games.
2 Select the most suitable models, methods and techniques for specific game-theoretic engineering problems.
3 Assess the outcome of games quantitatively and qualitatively.
4 Master the design of decentralized mechanisms.
5 Master the formulation and mathematical solution techniques of cooperative games.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Lecture, seminar: coached exercises

Learning materials and price

Course material: English syllabus + slides (via the electronic learning platform)

References

- Z. Han, D. Niyato, W. Saad. T. Basar, A. Hjørungnes. Game theory in wireless and communication networks. Cambridge University Press, 2012.
- T. Basar, G.J. Olsder, Dynamic Noncooperative Game Theory, SIAM, 1999
- M. Mashler, E. Solan, S. Zamir, Game Theory, 2013, Cambridge
- Y. Shoham, K. Lleyton-Brown, Multi-Agent Systems: Algorithmic,Game-Theoretic, and Logical Foundations, 2009, Cambridge

Course content-related study coaching

Evaluation methods

end-of-term evaluation

Examination methods in case of periodic evaluation during the first examination period

Written examination, open book examination

Examination methods in case of periodic evaluation during the second examination period

Written examination, open book examination

Examination methods in case of permanent evaluation

Possibilities of retake in case of permanent evaluation

not applicable

Calculation of the examination mark

Examination: 100%