Game Theory with Engineering Applications (E003700)

Course Specifications
Valid as from the academic year 2019-2020

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 2019-2020
- A (semester 1)  
  - English
  - UGent
  - on campus lecture: 30.0 h
  - on campus seminar: 30.0 h
  - coached exercises

Lecturers in academic year 2019-2020
- Steendam, Heidi  
  - TW07 lecturer-in-charge
- Fiems, Dieter  
  - TW07 co-lecturer

Offered in the following programmes in 2019-2020
- Bridging Programme Master of Science in Industrial Engineering and Operations Research  
  - 6 credits  
  - A offering
- Bridging Programme Master of Science in Industrial Engineering and Operations Research  
  - 6 credits  
  - A offering
- Master of Science in Electrical Engineering (main subject Communication and Information Technology)  
  - 6 credits  
  - A offering
- Master of Science in Industrial Engineering and Operations Research  
  - 6 credits  
  - A offering
- Master of Science in Computer Science Engineering  
  - 6 credits  
  - A offering
- Master of Science in Computer Science Engineering  
  - 6 credits  
  - A offering
- Master of Science in Industrial Engineering and Operations Research  
  - 6 credits  
  - A offering

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.

(Approved)
• **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
On campus lecture, self-reliant study activities, on campus seminar: coached exercises.

Learning materials and price
Course material: English syllabus + slides (via the electronic learning platform).

References

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 with open questions

Examination methods in case of periodic evaluation during the second examination period
Written examination with open questions

Examination methods in case of permanent evaluation

Possibilities of retake in case of permanent evaluation
not applicable

Calculation of the examination mark
Examination: 100%