Course description

Game Theory and Decision Making

1. **Course name, ECTS, quarter/semester, contact hours**

Game Theory and Decision Making, 3-4 quarter, 6 ECTS, 72 contact hours

2. **Author of the course**

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3. **Outline**

Theory of games is a theory for mathematical modelling of situations of conflict and cooperation between intelligent rational decision-makers. Such situations are, e.a., economic competition, military conflicts, voting problems and so on. Conflict situations are modelled by strategic non-cooperative games studying the optimal behavior of agents (players). Since the outcome of a conflict depends on the strategy choice of all players, there is no unique solution concept defining the optimal behavior of players. The main solution concepts: domination of strategies, Pareto optimality, Nash equilibrium and their refinements will be studied for static and dynamic models.

Cooperation supposes the joint behavior of players for the achievement of the maximal total gain.. The main problem of cooperation is how to divide this gain (or loss) among the players. The solution of this problem consists in mathematical modelling of fairness, which has no unique definition. Different traits of fairness are formalized in axioms, and then a complete and consistent set of axiom define a cooperative game solution being a sharing rule of the total gain. The main cooperative game solutions; the core, the Shapley value, the nucleolus et al. and their axiomatic characterizations will be studied.

Theory of decision-making in the course considers the mathematical modelling of the aggregation of different individual preferences in the unique social one. This is a part of the social choice theory. The main models are those connected with voting. An analysis of the most known voting rules and their connection with cooperative game solutions are given.

With studying the course a student becomes familiar with the following competences:

- an ability to improve his cultured grade;
- an ability on his own mastery of the new research methods, to the change of his research anf development profile in his professional activity;
- an ability to generalize and to estimate critically the results obtained by home and foreign researchers;
- to reveal directions having prospects, to compose research programs;
- an ability to estimate efficiency of projects taking into account an uncertainty factor;
- an ability to prepare analytical materials for an estimation of measures in economics and of strategical decision making on micro- and macro-levels

4. **Structure and content**

1. Non-cooperative games in normal form
2. Non-cooperative games in positional form

3. Social choice theory and voting problems
4. Cooperative games

Brief content of themes:

Optimality principles in non-cooperative games: domination of strategies, Pareto optimality, equilibrium points. Theorem of existence of equilibrium points in two-person concave games. Mixed extensions of finite games. The Nash theorem. Oligopoly games. Perfect equilibrium points, correlated equilibria. Models of auctions. Games with incomplete information. Games in positional form. The Theorem of Zermelo-Neumann on the existence of pure equilibrium points in games with perfect information. A decomposition of a positional games . Perfect sub-game equilibria. The perfect recall and behavioral strategies. Theorem of Kuhn. The methods of cost/surplus allocations. Egalitarianism and utilitarism. Bargaining problems. The Nash and the Kalai-Smorodinsky bargaining solutions. Social choice problems. Properties of voting rules. The existence of a Condorcet winner in models with single-peaked preferences. The Arrow theorem on dictatorial social choice rules. The definition of a cooperative game given a non-cooperative game. Solutions of cooperative games. The core. Necessary and sufficient conditions for non-emptiness of the core. Simple games and their cores. The Shapley value, its axiomatic characterization. The Shapley-Shubik power index in voting problems.

5. Prerequisites

For the successful mastering of the course students should be familiar with mathematical analysis, linear algebra, and probability theory at the basic undergraduate level and should be able to construct the corresponding mathematical models themselves, and also to find optimal ways of conflict resolutions. Thus, the students have to put and to solve problems. This ability is attained in the participation in seminars and practical studies.

6. Assessment

Type of testing	Form of testing	Parameters	Weight
Intermediate	Two control works	scores	The first control work – 20% The second control work – 20%
Intermediate	Seminar discussion	scores	10%
Final test	Exam	scores	50%