



Linear Quadratic Differential Games and Applications

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The game models and in particular the differential game models, which are rapidly developing during the last decade, are an efficient and an up-to-date instrument for the analysis of equilibrium states with their wide range of applications in the fields of the Economics, the Ecological, and the Engineering sciences. The finding of the equilibrium state is studied with regard to the derivation of the control function for the analyzed system in a way resulting in the rational behavior of participants in the process (the players), which in turn would ensure an equilibrium in the modelled system as well as the achievement of the optimal utility for all of the player. Considering the outstanding importance of this problem the Sofia University St. Kliment Ohridski and the Norway University of Science and Technology define this research field as a priority field for their joint research projects. Furthermore, the results of these studies could lead to the development of new teaching methods, including the application of ICT.

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One of the activities of the project is the Activity 3 Development of a PhD class of lectures. The goal of this activity is to increase the lecturers competencies as well as to strengthen the cooperation between Sofia University St.Kl.Ohridski and the Norway University of Science and Technology through a development of a joint PhD class of lectures including the utilization of ICT. This activity will be jointly accomplished by Professor Ivan Ivanov, Professor Lars Imsland, Professor Vasile Dragan and Associate Professor Snezhana Kostova. The result of this activity will be a developed class of lectures.

Further on, next activity is the Activity 4 Carrying out a PhD class of lectures. The goal of this activity is to strengthen the cooperation between Sofia University St.Kl.Ohridski and the Norway University of Science and Technology and also to improve the skills of the PhD students through the introduction of a joint class of lectures, including the utilization of ICT. This activity will be jointly performed by Professor Ivan Ivanov, Professor Lars Imsland, Professor Vasile Dragan, and Associate Professor Snezhana Kostova. As a result of this activity a PhD class of lectures will be carried out.

A PhD class of lectures will be jointly developed on the topic of Linear Quadratic Differential Games and Applications. The class is intended to support the learning process of the PhD students as well as to increase their competencies through acquaintance with the latest advances in the field. The total study load is planned to amount to 30 lecture hours.

The main objective of the PhD class is to provide knowledge on the latest advances in the theory of linear quadratic differential games as well as on its applications in different fields. Due to the diversity of its applications to the modelling of processes and phenomena as well as to the solving of optimization problems the class is intended for PhD students working in different scientific fields, such as Ecology, Energy Efficiency, Economics, Engineering Sciences, etc.

The class includes the following four parts:

Part I consists of introductory lectures on the basics in Linear Algebra and Mathematical Analysis, Linear Dynamical Systems, Control and Optimization Theory, Linear Quadratic Optimization and

Model Predictive Control. The topics will be taught within 8 lecture hours. The content of this part will be developed by Professor Ivan Ivanov, Professor Lars Imsland, and Associate Professor Snezhina Kostova. The results of the performed work will constitute a part of the methodical guide for the PhD class. The latter will be ascertained by an acceptance protocol signed by the Dean of FEBA (Faculty of Economics and Business Administration at Sofia University "St. Kl. Ohridski")

Part II covers the basics in Game Theory zero sum games, non-correlated and correlated games, equilibrium states definitions and properties, differential games and Nash-Riccati equations. The topics will be taught within 8 lecture hours. The content of this part will be developed by Professor Ivan Ivanov and Associate Professor Snezhina Kostova. The results of the performed work will constitute a part of the methodical guide for the PhD class. The latter will be ascertained by an acceptance protocol signed by the Dean of FEBA.

Part III introduces contemporary methods for Optimal Control based on the Game Theory. The following topics are included: Adaptive dynamic programming for online solution of a zero-sum differential game. This topic will be developed by Associate Professor Snezhana Kostova. Game theoretic approaches to solve H problems. This topic will be developed by Associate Professor Snezhana Kostova. Linear quadratic differential games with full information. The Lanzon method. Linear quadratic differential games with full information for discrete-time periodic systems Model Predictive Control Based on Game Theory.

Part IV is dedicated to the applications of the theory-game approach in the field of Economics and Engineering Sciences. Professor Ivan Ivanov will develop a lecture on the economic and financial markets applications. The lecture on the engineering applications will be developed by Professor Lars Imsland, and Associate Professor Snezhina Kostova. The lecture on the positive systems and methods for finding the Nash equilibrium point in differential games will be presented by Professor Vasile Dragan. The results of the performed work will constitute a part of the methodical guide for the PhD class.