Program: **BG09, "LINEAR QUADRATIC DIFFERENTIAL GAMES AND APPLICATIONS"**

Grant: Д03-91/ 27.05.2015
Sofia University "St. Kl. Ohridski"
Activity 4: Carrying out a PhD class of lectures "Linear Quadratic Differential Games and Applications"

FACULTY OF ECONOMICS SOFIA UNIVERSITY "St.Kl.Ohridski"

125 Tzarigradsko chaussee blv., bl.3, hall 417 , Sofia
PhD COURSE – THE PROGRAM

9 May 2016 Monday, hall 417
Prof. Ivan Ivanov
Ivan Ivanov received his Ph.D. in computational mathematics in 1994 from Sofia University "St. Kl. Ohridski". He is currently a full Professor at the Department of Statistics and Econometrics in the Sofia University. His research interests are in the areas of computational methods for solving nonlinear matrix equations and their applications. He did postdoctoral research at Sofia University and he obtained his doctor of science degree in applied and computational mathematics from Sofia University in 2008. His research activities include also optimal stochastic control problems, mathematical economics, nonlinear matrix equations, computational methods in the game theory. He is a member of the International Linear Algebra Society (ILAS). He is a member of a Editorial board of five international journals.

14:15 - 15:30 Lecture 1. Game theory - equilibrium states – definitions and properties. Linear quadratic games.
15:45 - 17:00   Lecture 2. Riccati equations with applications to the finding of the Nash equilibrium in the deterministic case. The game-theory approach for the solution of H_∞ optimization problems. The Lanzon method.
17:15 - 18:00 Lecture 3. Extensions of   Lanzon's method. Riccati equations with positivity properties.
18.00- 19.00 – Discussion

10 May 2016 Tuesday , hall 417
Assoc. Prof. Snejana Kostova
Snezhana Kostova received her MSc in Mechanical Engineering from Technical University, Rouse (1982), specialization of Applied Mathematics and Informatics at the Technical University of Sofia (1983) and PhD on *Control Systems* from the the Institute of Control and System Research (ICSR), Bulgarian Academy of Sciences (2002). She habilitated as an Associate Professor in

Application of Principles and Methods of Cybernetics in Different Areas of Science in 2007. From 2007 to 2010 she was Associate Professor at ICSR-BAS and since 2010 she is Associate Professor at the Institute of Systems Engineering and Robotics of BAS (ISER-BAS). Her research interests include theory and applications of dynamic systems, positive systems, modelling and robotics.

9:15 am - 10:00 am. Lecture 1. Game theory and engineering problems.
Coffee break   10:00 am - 10:30 am.
10:30 am - 11:30 am. Lecture 2. Application of game theory to distributed model predictive control.
11:45 am - 13:00   Lecture 3. Application of game theory to positive linear control systems
13.00- 14.00 – Discussion

11 May 2016 Wednesday
 Prof. Vasile Dragan

Vasile Dragan was born on 2 February 1950, in Valea Bolvasnita, Caras-Severin, Romania. In 1974 he received his undergraduate degree in mathematics and in 1979 his PhD from University of Bucharest, Faculty of Mathematics, Romania. He is now Senior Researcher at the Institute of Mathematics "Simion Stoilow" of the Romanian Academy, Department of Differential Equations. His research interests are in qualitative theory of differential equations mainly in singular perturbation techniques, stability theory and asymptotic expansions. Also, his current research interests include control theory, robust control for deterministic and stochastic systems, for finite dimensional and infinite dimensional systems both in time-invariant and time-varying cases. Lately, his interest is focused on numerical methods for computation of the stabilizing solutions of different classes of Riccati differential equations and algebraic Riccati equations.

He is the author or coauthor of six books and over 200 scientific papers dedicated to various topics on Differential Equations and Control Theory.

9:15 am - 10:00 am. Lecture 1. On the linear quadratic optimization problems and associated Riccati equations for systems modeled by Ito linear differential equations.

In this lecture, we deal with Riccati differential equations (RDE) and algebraic Riccati equations (ARE) arising in construction of the equilibrium strategy of a zero sum linear quadratic differential game (LQDG) in the case when the controlled system is described by a system of linear Ito differential equations with both state multiplicative and control multiplicative white noise perturbations.

Coffee break   10:00 am - 10:30 am.

10:30 am - 11:30 am. Lecture 2. On computing the stabilizing solution of the algebraic Riccati equation arising in connection with a class of zero sum stochastic linear quadratic differential games.

In this lecture we present a procedure for numerical computation of the stabilizing solution of an ARE arising in connection with a zero sum stochastic linear quadratic differential game in the case

when the controlled system is described by a system of linear Ito differential equations with both state multiplicative and control multiplicative white noise perturbations.

11:45 am - 13:30. Prof. Viorica Dragan – Discussion

12 May 2016 Thursday

Prof. Lars Imsland

Lars Imsland received the Ph.D. degree in electrical engineering from the Department of Engineering Cybernetics, Norwegian University of Science and Technology (NTNU), Trondheim, Norway. He was a Visiting Research Scholar with the Institute for Systems Theory in Engineering, University of Stuttgart, Stuttgart, Germany, for part of his Ph.D. studies. He was a Post-Doctoral Researcher with NTNU, a Research Scientist with SINTEF, Trondheim, and a Specialist with Cybernetica AS, before becoming a full-time Professor of Control Engineering with NTNU in 2009. His current research interests include theory and application of nonlinear optimizing control and estimation. Examples of applications are within the oil and gas industry (both drilling and production), active safety in the automotive industry, and the use of mobile sensor networks for monitoring of local ice features.

9:15 am - 10:00 am. Lecture 1. Lecture 1: Numerical methods
- Constrained optimization, nonlinear programming
- Direct methods for numerical optimal control
- Discretization approaches (shooting methods, collocation methods)
- Algorithmic differentiation, software

Coffee break   10:00 am - 10:30 am.

10:30 am - 11:30 am. Lecture 2. Model predictive control
- Receding horizon implementation
- Stability of model predictive control
- Linear vs nonlinear
- Economic vs regulatory objectives
- Example 1: Production optimization in oil and gas production

11:45 am - 12:30 am. Lecture 3. Application examples
- Example 1 continued.
- Example 2: Path planning for unmanned aerial vehicles for monitoring of ice features

12.30- 13.30 – Discussion

13 May 2016 Friday, hall 417

Assoc. Prof. Boryana Bogdanova

Boryana Bogdanova is Associate Professor at the Department of Statistics and Econometrics, Faculty of Economics and Business Administration, Sofia University "St. Kliment Ohridski". Since 2014 she holds a PhD degree in Economics. Her research interests are in the field of

International Stock Markets, Energy Markets, Empirical Finance, Applied Statistics, Econophysics and Wavelet Analysis. Among others, Boryana Bogdanova has been an invited guest editor for the special issue in Econophysics of Journal of Engineering Science and Technology Review and she has been awarded a certificate of recognized reviewer by Energy.

9:15 am - 10:00 am. Lecture 1. An Introduction to Global Coordination Games

Coffee break   10:00 am - 10:30 am.

10:30 am - 11:30 am. Lecture 2. An Application of Global Coordination Games to the Problem of Financial Contagion

 11:45 am - 12:30 am. Lecture 3. A Wavelet Application to Global Coordination Games Contagion Model.

12.30- 13.30 – Discussion and Closing

"Certificates" for successfully completed course of lectures will be awarded to the participants.

Questions and comments: i_ivanov@feb.uni-soifa.bg; bpelova@gmail.com