Fall 2017 - MATH 750-Stochastic Adaptive Control Theory

CLASS HOURS: 11:00 – 12:15, 156 Snow Hall

INSTRUCTOR: **Bozenna Pasik-Duncan,** Ph.D, D.Sc. Professor of Mathematics, Courtesy Professor of AE & EECS, Affiliated with ITTC & Computational Biology Center

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PREREQUISITES FOR THE COURSE: Some Probability and Statistics, Real Analysis knowledge, good academic standing, and permission of the instructor.

CLASS PROCEDURES AND GRADING:

LECTURES: Members of the class are expected to attend the lectures, which will be used to explain new material, to work typical examples and to answer some questions. The course will cover topics listed below.

EXAMINATION:

- Reading & Writing Assignments
- Title and Abstract of the Final Paper due by November 10
- FINAL PAPER (collaboration will be allowed) submission: the end of November
- Presentations of the Final Papers. December 1

  Final Paper is expected to be written in the form and the size of a short research paper, with the title, name, affiliation, abstract, key words, introduction, main results, conclusions, future work, references and acknowledgements if applicable. 10 minute presentations with class discussions will be scheduled.

  GRADING SYSTEM:

  Your grade in this course will be determined as follows:
  Participation in class: 20% reading & writing assignments: 30%, final paper: 50%

  CHANGES:

  The instructor reserves the right to modify the schedule announced in this bulletin if the conditions arise during the semester which make such changes desirable.

DESCRIPTION OF THE COURSE:

Stochastic adaptive control theory is concerned with recursive estimation of unknown parameters and control for systems with uncertainties modeled as random variables or random processes. The theory is motivated by applications in such diverse areas as aerospace guidance and control, signal processing and communications, manufacturing processes, and financial economics. Mathematical theory of identification, filtering, control and stochastic adaptive control for models based on stochastic difference equations such as autoregressive processes and stochastic differential equations as Markov diffusion processes have been developed and will be presented.

THE COURSE MAIN TOPICS:

- Conditional Expectation and its Properties. Introduction to ARMAX models.
- Linear Systems and their Properties.
- Linear Filtering Theory, Kalman Filter
- Introduction to the Optimal Control Theory. Feedback Control.
- Martingales and Limit Theorems of Probability
- Estimation Methods: Least Squares and Maximum Likelihood Method.
- Introduction to Stochastic Processes: Markov Chains and Brownian Motion.
- Introduction to System Identification. Identification of Markov Chains and Identification of Linear Systems.
- Adaptive Control of Markov Chains and Adaptive Control of Linear Systems.
- Application of Stochastic Adaptive Control.

RECOMMENDED TEXTBOOKS include:

- A first Course in Stochastic Processes, S. Karlin, H.M. Taylor
- Introduction to Stochastic Processes, S. Ross
- Discrete Time Stochastic Systems, T. Sodestrom
- Mathematical Theory of Statistics, Hogg/Tanis or Hogg/Craig or any other book
- Identification and Stochastic Adaptive Control, H.F. Chen, L. Guo
- Stochastic Modeling and Control, M.H.A. Davis, R.B. Vinter
- On Adaptive Control, (O Sterowaniu Adaptacyjnym) Research Monograph, Habilitation Doctorate Dissertation, (in Polish) B. Pasik, 1986
- Linear Systems, P. Antsaklis, A. Michel, McGraw Hill, 1997
- Introduction to Mathematical Systems Theory, Linear Systems, Identification and Control, Christian Heij, Andre Ran, Freek van Schagen, Birkhauser Verlag, 2007
- Feedback Systems, An Introduction for Scientists and Engineers, K. J. Astrom & R. M. Murray, 2008
- Stochastic Systems, Estimation, Identification and Adaptive Control, P.R. Kumar & Pravin Varaiya, SIAM