Course Number: 28627

Course Name: Stochastic Control Theory

Course Type: Theory	Type & Max Unit: Constant 3
Prerequisite: Advanced Control	Corequisite: Nothing.
Level: Graduate	First Presentation: 2010-1
Group: Applied mechanics	Last Edition: -.

Objectives:

In this course an introduction to stochastic control theory and some aspects of its applications are presented. At fist some preliminaries and basics of stochastic systems, stochastic calculus and stochastic differential equations are presented. Then the control of stochastic systems presented in transfer function forms and state space forms are studied. Besides, the theory of Kalman filter and Kalman-Bucy filter are presented.

Topics:

- **Introduction to stochastic control and its applications (0.5 hr)**
- **Introduction to stochastic process (6 hrs)**
  - Preliminaries, Probability, Stochastic process, Some special process (Normal, Markov, Steady, Weakly steady, Ergodic, Random walk (independent/orthogonal increment), Expected value function, Covariance function, Spectral density, White noise, Weiner process, Stochastic process analysis, Probability convergence, Stochastic continuity, derivative and integral.
- **State model for stochastic systems (7.5 hrs)**
  - Discrete time stochastic systems, Solution of discrete time linear stochastic systems, Continuous time stochastic systems, Stochastic integrals, Stochastic differential equations, Backward and forward differences, Ito calculus, Solution of continuous time linear stochastic systems, Nonlinear systems, Ito derivative, Sampling of linear continuous time stochastic systems.
- **Analysis of systems described by transfer functions with stochastic inputs (4.5 hrs)**
  - Discrete time systems describe by transfer functions, Spectral factorization for discrete process, Continuous time systems describe by transfer functions, Spectral factorization for continuous time process.
- **Parametric optimization (4.5 hrs)**
  - Calculation of loss function for discrete time stochastic systems, Calculation of loss function for continuous time stochastic systems, Reconstruction of state variables for discrete time systems, Reconstruction of state variables for continuous time systems.
- **Minimum variance strategy (4 hrs)**
  - One/Multi step ahead prediction for discrete time systems, Minimum variance control for discrete time stochastic systems.
- **Estimation and filtering theory (9 hrs)**
  - Estimation theory and its general formulation for stochastic vectors, Estimation theory for discrete time linear stochastic systems (Kalman filter), Estimation theory for continuous time linear stochastic systems (Kalman-Bucy filter), Prediction problem, Smoothing problem, Extended Kalman filter, Unscented Kalman filter
- **Linear stochastic control theory (9 hrs)**
  - Control of discrete time linear stochastic systems with complete state measurement, Incomplete state measurement problem, Control of continuous time linear stochastic system

References:

1- K. J. Astrom, Introduction to stochastic control theory, Dover Publications; 56.52 edition (January 6, 2006)
2- B. D. Anderson, J. B. Moore, Optimal filtering, Dover Publications (January 5, 2005)