Tárgytematika / Course Description

Automatic Controls

GKNM_AUTA011

Tárgyfelelős neve / Teacher's name: dr. Kuczmann Miklós
Félév / Semester: 2018/19/2
Beszámolási forma / Assesment: Vizsga
Tárgy heti óraszáma / Teaching hours(week): 2/0/0
Tárgy féléves óraszáma / Teaching hours(sem.): 0/0/0

OKTATÁS CÉLJA / AIM OF THE COURSE

TANTÁRGY TARTALMA / DESCRIPTION

I. Overview of automatic control fundamentals

- Control system structure, closed loop quality characterization.
- Dynamic system classes. Poles, zeros, basic connections, second order element.
- Tracking properties, stability criteria, phase margin, PID controller.
- Mathematical sampling, Shannon theorem, signal expansion.
- Approximation of differentiators and integrators, controller realization in discrete time.
- Stability criteria in discrete time.

II. Discrete time control of single variable (SISO) systems

- Two degree of freedom (2DOF) control design based on reference model.
- Control design for dead time systems using Smith predictor.
- k-step ahead predictor.
- Generalized predictive control .

III. Multivariable (MIMO) control design in state space

- Controllability, reachability, observability, reconstructability. Canonical forms. Algebraic similarity of continuous time and discrete time systems.
- Pole assignment using state feedback. Full and minimal order state observers.

- Generalized predictive control in state space.
- Decoupling with stability guarantee.

IV. Nonlinear control systems

- Stability (Lyapunov, asymptotic, global)
- Lyapunov's direct method. Lyapunov's indirect method. LaSalle theorem.
- Sliding mode control, elimination of oscillations.
- Backstepping control. Input/state linearization.

V. Optimal control systems

- Analytical conditions of static optimum. Karush-Kuhn-Tucker theorem. Lagrange multiplier rule.
- Numerical optimization methods in finite dimension. Optimum seeking in a single variable. Gradient, conjugate gradient, Newton and quasi-Newton methods. Davidon-Fletcher-Powell (DFP) and Broyden-Fletcher-Goldfarb-Shanno (BFGS) methods.
- Discrete time LQ control of LTV systems. Reciprocal roots condition for LTI systems, solution based on eigenvalue/eigenvector technique and algebraic Riccati equation (DARE).
- Kalman filter for LTV stochastic systems. Similarity to LQ control. Kalman filter for LTI systems. LQG control. Extended Kalman Filter (EKF) for nonlinear systems.
- Analytical conditions of dynamic optimum. Local maximum principle. Pontrayagin's maximum principle, bang-bang control.
- Continuous time LQ control of LTV systems. Symmetric roots condition for LTI systems, solution using eigenvalue/eigenvector technique and CARE.

VI. Identification and adaptive control

- Linear parameter estimation without and with forgetting. Batch and recursive algorithms. Nonlinear parameter estimation.
- Typical system and noise models. Cost function and its first and approximating second derivatives.
- Parameter estimation of ARX models using LS and IV (instrumental variable) methods.
- Parameter estimation of ARMAX model using numerical optimization based on quasi-Newton method.
- Identification of MIMO systems in state space. Hankel-parameters, shift invariance of generalized observability matrix. Linear algebra tools for solving N4SID and MOESP identification.
- Model predictive and selftuning adaptive control structures. Implicit (inverse) adaptive control of MIMO LTI systems.

SZÁMONKÉRÉSI ÉS ÉRTÉKELÉSI RENDSZERE / ASSESMENT'S METHOD

KÖTELEZŐ IRODALOM / OBLIGATORY MATERIAL

References:

Kailath T.: Linear Systems. Prentice Hall,1980.

Lantos B.-Márton L.: Nonlinear Control of Vehicles and Robots. Springer, 2011

Khalil H.K.: Nonlinear Systems. Prentice Hall, 2002

Lyung L.: System Identification: Theory for the User. Prentice Hall,1999