

Lecture Course on

# Optimal Control and Estimation

for Master Students in Engineering, Mathematics, Physics, and Computer Science  
(SS 2014, 5 ECTS, Technical Faculty of University of Freiburg)

Aim of this self contained lecture course is to provide the participants with a working knowledge of modern control theory as it is needed in engineering applications, with a focus on optimal control and estimation. At the end of the course the students shall have full understanding of how to use the linear quadratic regulator (LQR), the Kalman filter, Lyapunov and Riccati Equations, dynamic programming, constrained optimal control, moving horizon estimation (MHE) and model predictive control (MPC).

**Content:** Focus of the course is state space control in discrete time. We start by discussing discrete time linear systems, their basic stability properties, time varying systems, linearization of nonlinear systems. We then enter optimal control, covering linear quadratic optimal control, linear quadratic regulation (LQR) control and Kalman filtering, Lyapunov and Riccati Equations, Dynamic Programming, Constrained Optimal Control, Moving Horizon Estimation (MHE) and Model Predictive Control (MPC). The course will be accompanied by weekly exercises with exercise questions and computer exercises using the environment MATLAB. In the last four weeks of the course (July), the participants will start to work, during the exercise sessions, on self chosen optimal control and estimation application projects, whose results will finally be presented to all course participants at the end of the semester.

**Prerequisites:** The course is self contained and can be followed by all students with sufficient mathematical background. Thus, it is recommended to master and advanced bachelor students of engineering, computer science, mathematics, and physics.

**Time and location:** The lecture takes place in the Summer Term 2014 at the technical faculty of the University of Freiburg. The intended lecture dates are:

- Monday 10:00-12:00 in Georges-Koehler-Allee (GKA) 101, Room SR 00-010/014,
- Wednesday 16:00-18:00 also in GKA 101, but in Room SR 01-016,
- Exercises: Thursday 10:00-12:00 in GKA 078, SR 00-014.

Place and date may still be subject to changes. To register or obtain additional information, please write an email to [greg.horn@esat.kuleuven.be](mailto:greg.horn@esat.kuleuven.be) with subject "OCE Lecture", and fill in the doodle that might help us to find a better date: <http://doodle.com/tesgcrf3n8i8maxe>

**Lecturer:** Prof. Dr. Moritz Diehl, Control and Optimization Laboratory, University of Freiburg, and University of Leuven. Exercises: Greg Horn (PhD student, Freiburg/Leuven). <http://www.imtek.de/laboratories/systemtheorie>