Systems Control and Optimization Laboratory
IMTEK, Faculty of Engineering, University of Freiburg

AWESCO Spring School (3 ECTS) on

Numerical Optimal Control with Differential Algebraic Equations

February 15-26, 2016

University of Freiburg

For industrial and academic researchers, in particular PhD and master students in engineering, mathematics, physics, and computer science.

Lecturers: Sebastien Gros (Chalmers U), Joel Andersson (UW Madison), Joris Gillis (KU Leuven), Rien Quirynen (KU Leuven), and Moritz Diehl (U Freiburg)

The aim of this intensive two week course is to give both theoretical background and hands-on practical knowledge with computational tools for optimal control with differential algebraic equation models.

Content: The course covers all topics relevant for the formulation and practical solution of optimal control problems (OCP) with differential algebraic equation models. It builds on concepts from both, numerical simulation of differential algebraic equations and nonlinear optimization. All lecture topics are accompanied by intensive computer exercises, for which we use the optimization modelling environment CasADi from MATLAB or Python. The first week (whose contents are optional for experienced participants), contains an introduction into using CasADi, into convex optimization and nonlinear programming and into algorithms for general nonlinear optimal control problems such as direct single and multiple shooting and direct collocation. The second week focuses on optimal control with differential algebraic equation (DAE) models. Topics comprise implicit integration methods, high-index DAE, invariants, Baumgarte stabilization, periodic problems and optimal control under uncertainty.

Towards the end of the course, each participant will start to work on a self-chosen application problem and the results will be presented in a short public presentation on the last day of the course.

Prerequisites, Workload and Evaluation: The course is self contained and can be followed by all quantitative scientists with solid mathematical background (calculus and linear algebra) and knowledge of dynamic systems. It is recommended for both industrial and academic practitioners of control and optimization as well as for master and PhD students of engineering, computer science, mathematics, and physics. The total workload is 90 hours including lectures, project work and self-study, and the course gives 3 ECTS credits. The final course evaluation is based 50% on the written exam and 50% on the project. A certificate of attendance can be given to participants not wishing to participate in the exam and/or project.

Location and Schedule: The course takes place from Monday, February 15, 2016 to Friday, February 26, 2016, from 9:00-18:00, in the main historical university building in the city center of Freiburg (Kollegiengebäude I, HS 1098, Platz der Universität 3 , D-79098 Freiburg). In the weekend, an optional excursion into the black forest is foreseen. The written exam takes place on Thursday, February 25, 9:00-10:30. The final project presentations take place on Friday, February 26, 2016.

Registration: Participation in the course is limited to 60 places. A cost contribution of 300 Euro to cover coffee breaks and social events will be required by external participants. To apply for participation please fill in the form at http://goo.gl/forms/BT1LH6Y5Ma before December 15, 2015.

Organizers and teachers: The workshop is organized by Moritz Diehl, Dimitris Kouzoupis, Rien Quirynen, Robin Verschueren, Greg Horn, Christine Paasch and Andrea Zanelli, with Sebastien Gros (Chalmers), Joel Andersson (UW Madison) and Joris Gillis (KU Leuven) as external teachers. Support by the EU via the ERC Project HIGHWIND (259 166) and the ITNs TEMPO (607 957) and AWESCO (642 682) is gratefully acknowledged.

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