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

AWESCO Winter School (3 ECTS) on

Numerical Optimal Control with Differential Algebraic Equations

February 15-26, 2016

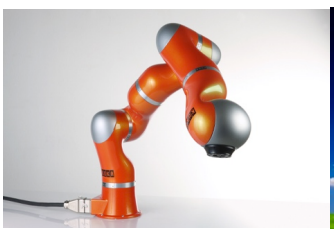
University of Freiburg

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

Lecturers: **Sébastien 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 course is to give both theoretical background and hands-on practical knowledge with computational tools for optimal control with ordinary differential and differential algebraic equations. The course is divided into two weeks that build on each other. In special cases, participation in only one of the weeks is possible.

Content: The course covers all topics relevant for the formulation and practical solution of optimal control problems (OCP) with differential algebraic equation models. All lecture topics are accompanied by intensive computer exercises, for which we use the optimization modelling environment CasADi from MATLAB (or Python). **First week:** (optional for experienced participants): introduction into using CasADi, convex optimization, nonlinear programming, algorithms for general nonlinear optimal control problems such as direct single and multiple shooting and direct collocation. **Second week:** optimal control with differential algebraic equation (DAE) models, implicit integration methods, high-index DAE, invariants, Baumgarte stabilization, periodic problems and optimal control under uncertainty. In the last two days, each participant works on a self-chosen application problem and the results will be presented in a short public presentation.



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), knowledge of dynamic systems, and some programming skills in MATLAB (or Python). 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, or participating in the first week only.

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 (150 Euro per week) 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 January 17, 2016.

Organizers and teachers: The workshop is organized by Moritz Diehl, Andrea Zanelli, Dimitris Kouzoupis, Rien Quirynen, Robin Verschueren, and Christine Paasch 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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