AWESCO Winter School on

Numerical Optimal Control with Differential Algebraic Equations

University of Freiburg, February 15 – February 26

Room 1098, Ground Floor Kollegiengebäude 1 (KG1), Platz der Universität 3, 79098 Freiburg

Welcome to Freiburg and to the Winter School!

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.
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. We are 52 participants from 20 countries with a teaching and organizing team of 12 people. We look forward to an inspiring week together!

The Organizers

Public Transportation

Public transportation in Freiburg is all run by VAG (Freiburger Verkehrs AG). The tram, bus, and subway system all have the same tickets. A one-way ticket within the city costs 2, 20 €. A cheaper option if you are planning on taking multiple trips is to buy 2 x 4-Fahrten-Karte. This costs 15, 40 € and gives you 2 tickets with 4 rides possible on each. You must punch the Fahrkarte in the machine once you board the vehicle. Transfers are allowed on the same ticket within a one hour period. Tickets can be bought on buses, or at ticket machines around the city.

Internet

You can access the internet via eduroam or ask us for temporary login details. (For the second option you need to download a VPN from the following website: https://www.rz.uni-freiburg.de/services/netztel/wlan-vpn/vpn-clients?set_language=en)

Eating out

During the course most of us have lunch at the university cafeteria Mensa Rempartstraße (Rempartstraße 18, 79098 Freiburg). Here you can obtain a Mensa Card for a deposit of 7 Euros. You can top up this card with cash and use it to pay for your meal. At the end of your stay you can return the card to receive your deposit back as well as any rest amount of money that is still on your card.

For Wednesday 17th February we have reserved some places in the restaurant MARTIN'S BRÄU in Freiburg (Kaiser-Joseph-Straße 237, 79098 Freiburg). This gives you an opportunity to socialize, have a drink or some food together.

Contact information

Should you encounter any problems please feel free to contact Andrea (+49 1575 897 1478) or Christine (+49 176 988 34570)

Systems Control and Optimization Laboratory / Lehrstuhl für Systemtheorie, Regelungstechnik und Optimierung
Prof. Dr. Moritz Diehl
Institut für Mikrosystemtechnik (IMTEK)
Albert-Ludwigs-Universität Freiburg
Georges-Köhler-Allee 102
79110 Freiburg
www.syscop.de

Course Program

AWESCO Winter School on Numerical Optimal Control with Differential Algebraic Equations, First Week from Feb 15-21, 2016							
	Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
9:00	Introduction into Optimization and CasADi	Numerical Simulation and Derivatives	Newton Type Optimization: SQP	Direct Single and Multiple Shooting	The Indirect Approach and Pontryagin's Maximum Principle		**Excursion**
10:30	**Coffee Break**	**Coffee Break**	**Coffee Break**	**Coffee Break**	**Coffee Break**		
11:00	Exercise 1	Exercise 3	Exercise 5	Exercise 7	Exercise 9		
12:30	**Lunch Break**	**Lunch Break**	**Lunch Break**	**Lunch Break**	**Lunch Break**		
14:00	Nonlinear Programming & Convex Optimization	Optimal Control Overview	Interior Point Methods	Direct Collocation	Optimal Control with TOMLAB		
15:30	**Coffee Break**	**Coffee Break**	**Coffee Break**	**Coffee Break**	**Coffee Break**		
16:00	Exercise 2	Exercise 4	Exercise 6	Exercise 8	Embedded Optimal Control with ACADO		
17:30	Extra Time	Extra Time	Extra Time	Extra Time	Extra Time		
18:00	**End**	**End**	**End**	**End**	**End**		
	18:30 Reception*		18:30 Dinner Reservation (self-payment)**				

* Peterhofkeller Freiburg, Niemensstraße 10, 79098 Freiburg
** MARTIN'S BRÄU, Kaiser-Joseph-Straße 237, 79098 Freiburg
*** Room HS1015, Ground Floor Kollegiengebäude 1 (KG1), Platz der Universität 3, 79098 Freiburg

AWESCO Winter School on Numerical Optimal Control with Differential Algebraic Equations, Second Week from Feb 22-26, 2016					
	Monday	**Tuesday**	**Wednesday**	**Thursday*** **	**Friday*** **
9:00	Differential Algebraic Equation (DAEs) Models	Optimal Control with DAEs	Optimal Control of Airborne Wind Energy Systems	Exam	Project Presentations
10:30	**Coffee Break**	**Coffee Break**	**Coffee Break**	**Coffee Break**	**Coffee Break**
11:00	Exercise 10	Exercise 12	Stability and Robustness Optimization for Periodic Systems	Project Work	Project Presentations
12:30	**Lunch Break**	**Lunch Break**	**Lunch Break**	**Lunch Break**	Project Presentations
14:00	High Index DAEs and Index Reduction	Periodic Optimal Control with DAEs	Project Work / Study Time	Project Work	**End**
15:30	**Coffee Break**	**Coffee Break**	**Coffee Break**	**Coffee Break**	
16:00	Exercise 11	Exercise 13	Project Work / Study Time	Project Work	
17:30	Project Commitments	Extra Time	Project Work / Study Time	Extra Time	
18:00	**End**	**End**	**End**	**End**	
		18:30 Dinner*			

List of Organizers and Teachers

Name	Institution
Joel Andersson	UW Madison, USA
Moritz Diehl	University of Freiburg, Germany
Gianluca Frison	University of Freiburg, Germany
Joris Gillis	KU Leuven, Belgium
Sébastien Gros	Chalmers University, Sweden
Dimitris Kouzoupis	University of Freiburg, Germany
Elena Malz	Chalmers University, Sweden
Christine Paasch	University of Freiburg, Germany
Rien Quirynen	University of Freiburg, Germany
Per Rutquist	TOMLAB
Robin Verschueren	University of Freiburg, Germany
Andrea Zanelli	University of Freiburg, Germany