**Stuttgart International Summer School · Mobility**
25 June – 11 July 2018
System Competence in Electric, Hybrid and Combustion Powertrains, Aerodynamics and Aeroacoustics

**Logistics**

**Location:**
FKFS, Pfaffenwaldring 12, 70569 Stuttgart, Germany

**Accommodation:**
Conference hotel campus.guest, Universitätsstraße 34, 70569 Stuttgart, Germany
www.campus-guest.de
Please make your own reservations. Room allotment available until 14 days before start of course. Reserve using keyword: Summer School Course.

**Format and Delivery Method:**
Each course is a non-credit graduate level seminar consisting of lectures and exercises or lab sessions.

**Materials:**
A comprehensive set of notes will be provided on the first day of the course.

**Social Evening:**
On the first or second evening of the course there will be a social get-together during which the participants of the Stuttgart International Summer School will have the chance to network in a relaxed and comfortable atmosphere. Taking part in the social evening is optional and included in the course fee.

**Schedule**

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1 Day 1: 8:30 – 17:30, Day 2: 8:30 – 16:00
2 Day 1: 8:30 – 17:30

**Registration Fee**

Course 1 / 2 / 3: 1,900 € + VAT
Course 1a / 2a (Overview Courses): 950 € + VAT
Course 1 and 2 together: 3,400 € + VAT

Courses 1 and 2 can be taken stand-alone or in sequence.

**Group Discounts:**
2 participants of the same organization registering at the same time: 10 % discount.
3 participants of the same organization registering at the same time: 15 % discount.

The registration fee includes:
- A comprehensive set of notes
- Lunch, cold drinks and coffee at break times
- Access to a social evening

**Registration**

Sign up now: www.stuttgart-summerschool.de/registration
Registrations until 28 May 2018 (thereafter subject to availability).
Course 1 + 1a: System Integration, Simulation and Energy Management of Hybrid Electric Vehicles

Learn HEV System Simulation Methods for SIL and HIL Development of HEV Energy Management Strategies

Course Objectives:

The objective of this course is to introduce the participants to HEV system integration and energy management concepts using modern simulation methods based on Matlab/Simulink tools. The participants will use a modular simulator compatible with software- and hardware-in-the-loop control development systems, describing the energy flows in conventional and hybrid vehicles and analysing energy management strategies in a series of computer laboratory exercises that culminates with the participants developing their own energy management strategy based on the simulator developed during the course. Participants receive a copy of the modular Matlab/Simulink simulator used in the exercises.

Objective 1: (Courses 1 + 1a)
Evaluate energy consumption in road vehicles. Relate energy demand of driving cycles to fuel economy and CO₂ emissions. Understand the concept and potential benefits of drivetrain hybridization strategies.

Objective 2: (Course 1)
Develop mathematical models of energy use in combustion engine and transmission subsystems and use these models in a vehicle simulator to predict fuel consumption and CO₂ emissions.

Objective 3: (Course 1)
Develop mathematical models of electric traction drives and energy storage systems, used in hybrid vehicles. Use these models in electric and hybrid vehicle simulators to predict energy use and CO₂ emissions.

Objective 4: (Course 1)
Learn principles of energy management for hybrid electric vehicles, including mathematical methods such as Dynamic Programming, as well as real-time implementable strategies such as EEMS. Explore and improve HEV supervisory control design and energy management using a hybrid-electric vehicle simulator.

For a more detailed description of the course please visit www.stuttgart-summerschool.de

Goals:

Upon completion of the course the participants will be familiar with energy analysis and modelling of hybrid-electric power-trains, with some principles of optimal control, with Matlab/Simulink tools for vehicle energy analysis and supervisory control, and with the design of energy management strategies using StateFlow®.

Lecturer:

Prof. Giorgio Rizzoni, The Ohio State University

Gio Rizzoni is the Ford Motor Company Chair in ElectroMechanical Systems, a Professor of Mechanical and Aerospace Engineering and of Electrical and Computer Engineering at The Ohio State University (OSU). He received his B.S. (ECE) in 1980, his M.S. (ECE) in 1982, his Ph.D. (ECE) in 1986, all from the University of Michigan. Since 1999 he has been the director of the Ohio State University Center for Automotive Research (CAR), an interdisciplinary research center in the OSU College of Engineering. He is an author or co-author of 500 journal and conference papers, and three books. He is a Fellow of SAE (2005), a Fellow of IEEE (2004), a recipient of the 1991 National Science Foundation Presidential Young Investigator Award.

Course 2 + 2a: Energy Storage Systems for E-Mobility

Learn Lithium Ion Battery Technology and Energy Storage Systems for Electric Vehicles

Course Objectives:

The course introduces the participants to energy storage systems for electric vehicles based upon lithium ion battery technology. The course is designed to provide engineers and managers in the automotive industry with a broad overview on the subject, covering multiple areas such as cell materials and fundamental properties, testing procedures for performance characterization, modeling and simulation, system integration, control, diagnostics and prognostics. The course is a combination of lectures, case studies and computer laboratory exercises. During the laboratory sessions, the participants will utilize Matlab/Simulink tools to design and calibrate a lithium-ion battery model, develop a state-of-charge estimation algorithm and a simple strategy for battery pack charging and balancing.

Objective 1: (Courses 2 + 2a)
Explore the state of the art of lithium ion batteries for automotive applications, their operating principles, materials, and future directions of technical development.

Objective 2: (Courses 2 + 2a)
Learn the experimental methods required to characterize the performance of batteries.

Objective 3: (Course 2)
Develop mathematical models that predict the performance (dynamic voltage/current relationship) of lithium ion batteries and the mechanisms that lead to capacity and power fade.

Objective 4: (Course 2)
Learn principles of system integration and related issues, such as design and packaging, thermal management systems (TMS), and battery management systems (BMS) hardware and software architectures.

Objective 5: (Course 2)
Utilize mathematical models to design simple algorithms for SOE estimation, pack charging and cell balancing.

Note:

You may choose to take only Day 1 for an “executive-style” overview of lithium ion battery technology (state of the art, directions of development, challenges and opportunities for the automotive industry), or the full course for delving deeper into the technical topics.

For a more detailed description of the course please visit www.stuttgart-summerschool.de

Goals:

Upon completion of this course, the participants will possess practical knowledge of (1) Operating principles and characteristics of lithium-ion batteries, including the effects of electrode/electrolyte materials on performance and durability; (2) Experimental methods for characterizing performance and life of Li-ion cells, in support of modeling, design and prototype verification; (3) Modeling and simulation tools to solve system-level design and optimization problems for battery packs for EVs and HEVs; (4) Common system integration and control issues (electrical and thermal management, state estimation, etc.), and solution methods.

Lecturer:

Prof. Marcello Canova, The Ohio State University

Marcello Canova is Associate Professor of Mechanical and Aerospace Engineering at The Ohio State University, and Associate Director for Graduate and Continuing Education at the Center for Automotive Research. His research focuses on the optimization and control of propulsion systems, including internal combustion engines, hybrid-electric drivetrains, energy storage systems and thermal management. Dr. Canova’s work in energy optimization of advanced powertrains has led to significant fuel economy benefits and has been implemented in production programs by major OEMs. In addition, he has published over 110 articles in refereed journals and conference proceedings and received, among others, the SAE Vincent Bendix Automotive Electronics Engineering Award (2009), the SAE Ralph E. Teeter Educational Award (2016), the NSF CAREER Award (2016), the Lumley Research Award (2016) and the Michael J. Moran Award for Excellence in Teaching (2017).

Course 3: Vehicle Aerodynamics and Aeroacoustics

Know-how in Theory, Measuring Technique and Testing

Course Objectives:

The course is designed to provide a detailed understanding of vehicle aerodynamics and vehicle aeroacoustics. The participants will be trained to be able to carry out respective development work at car manufacturers and suppliers under consideration of the various interfaces to other disciplines.

Objective 1: Understand basic aerodynamic physics and relationships; apply fundamental aerodynamic equations on standard flow situations; assess aerodynamic coefficients and aerodynamic results; influence on vehicle drag and lift as well as vehicle dynamics.

Objective 2: Understand the principal acoustic and aeroacoustic physics; choose the adequate measurement instrumentation and setup; acquire expertise to assess aeroacoustic analyses and results.

Objective 3: Understand the approaches when implementing computational methods in aerodynamics and aeroacoustics; being able to assess the possible field of application and the advantages and disadvantages concerning the various numerical methods realistically.

Objective 4: Learn to plan and conduct aerodynamic and aeroacoustic investigations under experimental conditions in our modern wind tunnel facilities (full-scale aeroacoustic and scale-model wind tunnel as well as bench (thermal wind tunnel)) and to evaluate the measured data.

For a more detailed description of the course please visit www.stuttgart-summerschool.de

Goals:

After having completed this course, the participants will have a fundamental knowledge about vehicle aerodynamics and aeroacoustics. They will be able to use high-tech aerodynamic and aeroacoustic test tools and techniques to carry out wind tunnel tests, both in order to effectively perform aerodynamic and aeroacoustic development work on cars and to consider the interfaces to other disciplines.

Lecturer:

Prof. Dr.-Ing. Jochen Wiedemann, University of Stuttgart

In 1997 Professor Wiedemann received his diploma degree in mechanical engineering from Ruhr-Universität, Bochum, Germany. After carrying out aerodynamic research at the von-Karman Institute for Fluid Dynamics in Belgium and Ruhr-Universität Bochum he received the doctoral degree (Dr.-Ing.) in 1993 for his work on aerodynamic drag reduction. In 1994 Professor Wiedemann joined Audi AG where he held several managing positions. In 1998 Jochen Wiedemann was appointed Chair Professor of Automotive Engineering at the Institute for Internal Combustion Engines and Automotive Engineering (IVK) at the University of Stuttgart, Germany and he became a Member of the Board of Management of FKFS. His research work is largely associated with aerodynamics/aeroacoustics, road load and vehicle dynamics.

Co-lecturers:

Dr. Reinhard Blumrich, FKFS, Head of NVH Department, Nils Widdecke, IVK/FKFS, Head of Aerodynamics, Dr. Timo Kuthada, FKFS, Head of High Performance Computing, Dr. Felix Wittmeier, FKFS, Head of Model-Scale Wind Tunnel.