

As of January 2017, over 12 million hybrid electric vehicles and over 2 million battery electric vehicles have been sold worldwide. China and the United States are market leaders in battery electric vehicles and Japan is market leader in hybrid electric vehicles with 1.5 million hybrids being delivered in Europe since 2000. The performance of the electric power train has been substantially increased in the last two decades compared to electric motors for industrial applications with conventional designs. The certificate course **Technology of Hybrid & Electric Vehicles** provides insights on this interdisciplinary and rapidly progressing field of technology.

Course Benefits & Take Away for Participants

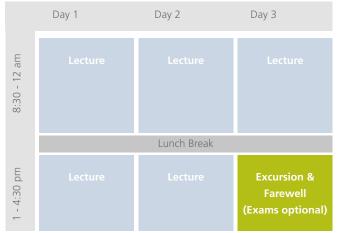
The participants will

- gain a detailed knowledge of all drive train topologies for electric and hybrid electric vehicles and their benefits and shortcomings in specific applications (types of vehicles);
- have a detailed understanding of the technical function and construction alternatives of all components required for electric drive trains, namely electric machines, power electronics and energy storage systems. This includes the underlying physical and technical principles as well as practical implementations in current electric vehicles;
- be enabled to specify appropriate drive train topologies and components for electric vehicles based on a detailed analysis of the energy and power demand for a given use-case (driving profile).



Overview Course Agenda

The structure of the course is leading from the general technical requirements of hybrid and electric drive trains, to details on available technical solutions and finally to the components (motor, power electronics and energy storage systems).



Hybrid Drive Trains

- Electrical Drive Trains
- Energy Demand of Cars
- Energy Storage Systems
- Basics of Rotating Electric Machines
- Induction Machines
- Synchronous Machines
- Power Electronics
- Charging
- Excursion

Exemplary Schedule of a 3-day Certificate Course



Agenda in Detail

Day 1:

Introduction

Session 1: Hybrid Drive Trains Variants of hybrid drivetrains | Serial, parallel & power split hybrid drives | Complex structures & practical examples

Session 2: Electrical Drive Trains

Electric motor variants | Torque-speed performance of electric motors | Electric motors & gearboxes | Performance comparison of electric motors & combustion engines | Design rules & power-toweight-ratio | Electric drive trains (shaft, wheel, and wheel hub drives)

Session 3: Energy Demand of Cars Driving resistances | Auxiliary components | Energy flow | Driving cycles

Session 4: Energy Storage Systems I Characteristics of electric batteries

Day 2

Session 5: Energy Storage Systems II Lithium ion batteries | Fuel cells

Session 6: Basics of Electrical Machines Rotating fields | Calculation MMF curve | Calculation force & torque | Mechanical design & construction | Materials (copper, aluminum, soft magnetic material, hard magnetic material) | Losses in electric machines

Session 7 & 8 : Induction Machines/ Synchronous Machines

Operating principle | Modelling (equivalent circuit diagrams) | Performance (torque-speed-characteristics) | Losses

Day 3

Session 9: Power Electronics

Components (diode, thyristor, power transistors, MOSFET, IGBT) | Topology of power electronics in electric cars | DC/DC-converter | DC/AC-converter

Session 10: Charging

Tethered & contactless charging

Company Visit

Registration & Organizational Details

| Duration | 3 days |
|--------------|---|
| Price | 2.495 € per participant |
| Group Size | max. 15 participants |
| Certificate | Certificate of the HECTOR School of Engineering & Management, Technology Business School of the Karlsruhe Institute of Technology (KIT) |
| Requirements | First University Degree (Bachelor or equivalent) |
| | A minimum of 5 years of professional experience in the specific field of the course is recommended. |
| | The course can be held in German or in English – appropriate skills in the respective language are required. For international companies translators can be hired. |
| Registration | Register online via: |

www.hectorschool.kit.edu/certificate_courses.php



For consultancy or company arrangements please contact:

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Course Instructor



Prof. Dr.-Ing. Martin Doppelbauer Professorship Hybrid Electric Vehicles (HEV) at the Karlsruhe Institute of Technology (KIT)

Prof. Dr.-Ing. Martin Doppelbauer was appointed with the professorship at HEV at the KIT in 2011.

At HECTOR School he combines his scientific expertise with more than 15 years of industry experience: From 2002 - 2011 he signed responsible as *Head of Electric Motor Development* for SEW Eurodrive and previously from 1995 - 2011 as *Head of Development* at the Danfoss Bauer GmbH.

