



Electrical Powertrain - From battery charging to electric machine torque

This course will dive into the engineering solutions behind electric powertrains, starting at charging inlet, through battery storage, inverter and electric machines. The content is aimed for engineers with previous experience in vehicle powertrain development who want to refresh or pick up on the key technologies within vehicle electrification. The course material is based on lectures, hardware tear-down demos, videos, discussions and a electric machine lab. The lecture material is a mix between in-depth theory and system overviews. The lecturer is a specialist with a decade of experience in electric powertrain development.

Course length: 16 hours, mixed as lectures, demos and labs

Course overview:

- Vehicle powertrain energy supply and power generation
 - Drive cycles, efficiency, energy consumption
- Electric machine theory and machine types
 - DC machine, permanent magnet synchronous, induction machine
- Electric machine control theory – DC and three-phase machines
 - Controller design and dq-transformation
- Three-phase power electronics: inverter
 - PWM, components, system interaction, losses
- On-board charger and DC/DC-converter
 - Electrical schematic examples
- On-board energy storage systems
 - Lithium-ion systems
 - Electrical safety, robustness and voltage levels
 - Cells, available li-ion chemistries, form factors
 - Equivalent circuit model
 - Battery Management Systems

Course target group:

Automotive engineers with former experience in vehicle powertrains.

Course outcomes:

- Identification of powertrain components and their key functionalities within a system, from charging to wheel torque
- Describe the essence of machine control and its challenges
- Better understanding of technical requirements for electrical powertrain components
- Identify and differentiate between electric machine types (DC, PMSM, IM)
- Identify and understand the key components in a traction inverter
- Relating to drive cycle implications in energy consumption and power requirements
- Relating to the internal functions and electrical functionality of an on-board charger