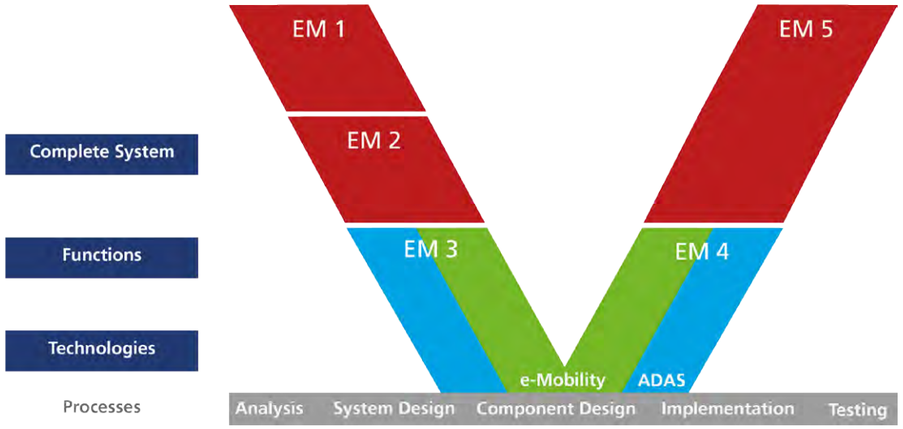
Engineering Modules (EM)

State-of-the-Art Technology Expertise in Mobility Systems



EM 1: Processes, Methods & Tools of ESEM

In EM 1 an introduction to embedded systems & software engineering is given. Processes, methods and tools from object oriented approaches via the V-model to agile methods are presented (e.g. Scrum). Among those, HW-/SW-Co-design and rules how to decide which way to go are explained. How to assess these approaches according to process maturity levels (e.g. SPICE and CMMI) and how to follow the demands of safety (relying on ISO 26262 and ASIL) and security is introduced focusing on the transportation industry.

Data of sensing and communication are the base for nearly all upcoming new functions of mobility. The importance and methods of their analysis such as anomaly detection is introduced. A case study based on the implementation of a two wheeled transportation platform ("Segway") gives a hands-on impression on the complexity of mechatronics system design.

EM 2: Components of Electronic Systems

In order to realize an embedded system in EM 2 a concrete EE-architecture is designed to modularize the complete functionality. Controllers and processors or ASICs and FPGAs will implement the applications and interact among each other. Data Communication Topologies and Technologies (e.g. CAN, Flexray or wireless/car2x, Ethernet) are appropriate for that. The interfaces to the environment are enabled by actuators and sensors. All these technologies will be explained in this module and the vision of mobility of the future is described conceptually.

EM 5: Systems Integration & Validation

Finally implementation and integration leads to testing the overall system according to the early requirements. During the overall process of engineering, testing has been prepared and done in order to check the maturity level. Quality assurance has been executed in simulations and prototyping environments. At the end of those phases, the real system can be tested for the first time to finally check the user requirements in a hardware-in-the-loop environment or even in real test scenarios.

Specialization e-Mobility

EM 3: E-Mobility: Political & Technical Framework

New concepts and new infrastructures are needed for the local supply of electric energy to plug-in and for full electric vehicles. Energy management starts with the generation of energy, which should ideally be done locally, and includes topics like energy storage and energy distribution, as well as intelligent new charging concepts that are geared towards momentary electricity production and consumption.

NVA (noise, vibration, harshness) becomes increasingly challenging as the reduced noise level of electric drives makes sound sources audible that have hardly played a role in conventional vehicles. Charging technologies & recuperation strategies play an important role in increasing the limited driving range.

EM 3 provides an overview of the boundary conditions for electric and hybrid electric traction vehicles, including transportation market policies, well-to-wheel climate impact analysis, energy management, and distribution.

EM 4: E-Mobility: Components & Technology

The electric power train (i.e. the mechatronic integration of energy storage, power & signal electronics, drive control, and electric motor) is the most innovative and important new part of hybrid and full electric vehicles compared to conventional combustion engine cars. High-speed electric motors become more and more powerful in recent years with new technologies like rare earth magnets and field weakening operation. The power-to-weight ratio of modern traction motors is more than a magnitude better compared to industrial electrical machines.

EM 4 focuses in detail on the technical components of electric and hybrid drive trains, namely the electric machine, power electronics (both hard- and control software), gearboxes, driving resistances and energy consumption and energy storage systems (batteries and fuel cells).

Specialization
Advanced Driver Assistance Systems (ADAS)

EM 3: Data Communication Technologies & Systems

Autonomous driving will redefine the automotive world. Vehicles will become able to perceive their environment and react autonomously to reduce the risk of accidents, to improve driving efficiency and comfort. Autonomous driving has the potential to improve traffic flow, reduce traffic congestions and save energy. Enhanced traffic management systems will increase the ability of the driver to interact with the car and the surrounding traffic. EM 3 will focus on the functions.

The most important control system in the car remains the driver. To get the driver´s acceptance it is very important to create attractive vehicle concepts where the control systems delivers an understanding for its sensation, cognition and action. This module addresses different aspects of the driver vehicle interaction. The drivability deals with the driver's usability of a vehicle, including ease of use, fulfillment of the driver's expectations concerning a safe, comfortable and efficient drive, degree of complexity of the driver-vehicle interface, and predictability of the vehicle's action and reaction. Many different methods to evaluate the driver's needs, benefits and acceptance exist and will be presented. Additionally, models of traffic flow and traffic management are introduced. Traffic demand modeling as a core concept for modern traffic management will round up the topic.

EM 4: Components & Technologies of ADAS

Modern vehicles have become more and more intelligent. Sensors and cognitive control units detect and communicate with the environment, recognize other vehicles and other traffic participants. They interpret and predict their behavior and improve road safety dramatically. Based on detailed road, infrastructure and traffic data and by using predictive green routing and vehicle operation management, a comfortable, energy and time efficient drive is realized.

Many components of actual and future cars are coming along with properties, which differ significantly from those in classical vehicles, such as high torque at zero speed, limited cruising range, need for additional battery charging infrastructure and cost accounting systems, high voltage safety requirements, different noise and vibration, autonomous actions etc. Consequently, new vehicle concepts and operation strategies are needed, which also affects the human to machine interaction. Also perception systems play an important role for the safety, comfort, and efficiency of mobile machines. Therefore fundamentals of sensor technologies are introduced and an overview on methods for scene perception is given to enable students to assess the uncertainties associated with these.

Engineering Modules

EM 1: Processes, Methods & Tools of Systems Engineering

Courses: Fundamentals of Systems Engineering | Modeling & Simulation | Process Models & Associated Assessments | Case Study in Embedded Systems Development (incl. Rapid Prototyping) | Big Data

EM 2: Systems Design

Courses: Control Systems Development | Embedded Systems Computer Architecture | Electronic Systems Synthesis (Hardware & Software) incl. Case Study | Concept Study: The Car of the Future

EM 5: Systems Integration & Validation

Courses: Quality Assurance Management & Cost of QA of Electronic Systems | Testing Automotive Systems (XiL, virtual testing,…) & Case Study | Release-, Configuration- & Update-Management of Self-Learning Functionality

Specialization Advanced Driver Assistance Systems

EM 3: Functions of ADAS

Courses: Driver Assistance Systems | Auto Control Systems | Driveability | Traffic Engineering & Control | xxx xxx xxx

EM 4: Components & Technologies of ADAS

Courses: Automotive Radar Technology | Optical Actors & Sensors | Mobile Perception Systems | IT Safety & Security | Hands on Training

Specialization E-Mobility

EM 3: E-Mobility: Political & Technical Framework

Courses: Introduction into Requirements, Solutions & Challenges of E-Mobility | CO2-balances: Well to Wheel | Transportation Market Policies | Energy & Management | Noise, Vibration & Harshness for E-Mobility | Case Study

EM 4: E-Mobility: Components & Technology

Courses: Electric Drive Trains | Power Electronics | Energy Conversion & Output | Energy Storage: Batteries & Fuel Cells | Energy Storage: H^2-Storage