Engineering Modules (EM)

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

EM 1: ICE, Power Train & Energy Storage

As an introduction to the master program, its first module provides a review about the **requirements, approaches, and challenges of sustainable future mobility systems**. Those are given by social, environmental, economic, political, and user needs. They foster the creation of new solutions on different levels: traffic, energy, data infrastructure, mobility behavior, driver vehicle interaction, vehicle subsystems and components, functional elements and new materials. New vehicle and traffic concepts are based on that.

The module than refers to **drive systems and their interaction**, describes energy carrier and storage starting with alternative fuels and modern internal combustion engines followed by storage systems for electrical drive systems. The lecture entitled "Energy conversion" presents **conventional and new power train systems**. The module also covers the **transmission from the wheel to the road** and is concluded by today's **advanced control systems**.

EM 2: Electric Power Train

In the recent past and foreseeable future, most innovations in conventional automotive systems are closely linked to **new developments in electronics**. In hybrid and pure electric vehicles the **electric power train, i.e. the mechatronic integration of energy storage, power and signal electronics, drive control and electric motor,** is technically the most innovative and important part of the vehicle. The need for **communication between sensors, actuators and control units** has massively increased. **Faster communication systems** are being created.

An important key to reduce the complexity of software of signal electronics and sensors are **structured multi-source software development tools and provisions for safe memory sharing of code** from different suppliers. Power electronics is now capable of higher switching frequencies to reduce losses and audible sound. Sophisticated control algorithms further improve motor performance. High-speed electric motors have become more and more powerful in recent years with new technologies like rare earth magnets and field weakening operation.

Starting with the fundamentals in electrical engineering, the module covers the **topologies of electric motors, principles of power electronics, and systems engineering**, including a comprehensive case study.

EM 3: Vehicle Driver Interaction

Modern vehicles are becoming more and more intelligent. Sensors and cognitive control units detect and communicate with the environment, recognize other vehicles and other traffic participants, 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. Many control units are used in the vehicle.

The most important control system in the car is the driver. Understanding its sensation, cognition, and action is very important to create attractive vehicle concepts and to get the driver's acceptance. 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 in this module.

EM 4: Success Factors of Green Mobility

Developing future "Green Mobility" products requires advanced technologies and production systems as well as an understanding of supply and demand in transportation markets. Those factors are boundary conditions for the successful implementation of future mobility systems.

This module introduces **lightweight strategies** and **methods of manufacturing as well as production systems for e-mobility**. The key aspects of **electric energy distribution systems and management** are addressed. Participants are enabled to **evaluate vehicle concepts based on the total cost of ownership and well-to-wheel CO2-emission scenarios**. **Transportation markets** and their specific mechanisms, trends in travelling demand and economy as well as political regulations are further topics. Finally, participants are enabled to analyze market opportunities for future projects.

EM 5: Vehicle Traffic Interaction

This module extends the scope of green mobility to include the **perspective of multiple cars interacting on the road and with traffic-related infrastructure**. Cars 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.

This module introduces **technologies for vehicle perception based on lidar, radar and visual camera sensors**. The interpretation of the sensor signals to obtain a consistent model of the environment is demonstrated. The latest developments in **car-to-x-communication systems** are presented and improvements in safety and traffic flow are discussed. Finally, **models of traffic flow and traffic management** are introduced. Traffic demand modeling as a core concept for **modern traffic management** is included in this module.

Engineering Modules

EM 1: ICE, Power Train & Energy Storage

Courses: Introduction into Requirements, Solutions & Challenges of Green Mobility | Advanced Green Combustion Engines/ Bio Fuels | Energy Storage: Batteries, Fuel Cells, H^2 | Energy Conversion | Energy Output | Automotive Control Systems

EM 2: Electric Power Train

Courses: Selected Topics of Electrical Engineering | Electro Engines | Power Electronics | Systems Engineering | Case Study in Electronic Systems Development

EM 3: Vehicle Driver Interaction

Courses: Drivability | Noise Vibration & Harshness (NVH) | Driver Assistance Systems | Automotive Radar Technologies | Human Factors Engineering

EM 4: Success Factors of Green Mobility

Courses: Light-Weight Construction & High-Performance Fiber | Production Systems for E-Mobility | Energy Distribution | CO_2-Balances: Well to Wheel | Transportation Markets & Policy

EM 5: Vehicle Traffic Interaction

Courses: Perception of the Environment | Auto-Control Systems | Traffic Engineering & Control | Technical Cognitive Systems | Car-to-X Communication

Order your free course guidebook with detailed contents & learning targets of the master program!