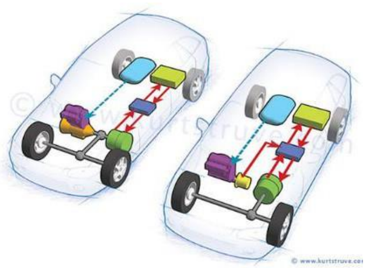
Electric and hybrid vehicles

Electric and hybrid vehicles	
Offered by	Department of Electrical Engineering
Language	English
Primarily interesting for	Primarily for AU and EE, but also for ME/TN.
Prerequisites	For EE and AU: • Power electronics (5APA0), • Control Systems (5ESD0), • Engineering Systems Design for Electric & Hybrid Powertrains (4AUB10). For ME: • Dynamics and control of mechanical systems (4DB00)
Contact person	dr.ir. M.C.F. Donkers (m.c.f.donkers@tue.nl)

Content and composition

Thinking in terms of systems. This is a central theme in our Automotive programme at TU/e. To get the highest level of efficiency from the technology, the design of vehicles requires a full system analysis and optimization of the parts/disciplines that work together in the vehicle. In new cars 50% of the added value comes from microprocessors, electrical, electromechanical and network components. This percentage continues to rise in the near future. The challenge to the car industry is to ensure that the integration of sub-systems in the car does not compromise performance, reliability, safety and profitability. In this elective package the key topics for future automotive solutions are provided.



EE and AU students*:

Course code	Course name	Level classification
5XWC0	Energy management	3
5XWB0	Electric drive systems	3

*Also possible for W, TN, but with **mandatory** prior knowledge: Electromechanics (5EWA0)

W, TN, (Wsk, Inf, SI) students:

Course code	Course name	Level classification
4AUB10	Engineering Systems Design for Electric & Hybrid Powertrains	2
5XWC0	Energy management	3

Please note. This coherent package used to include course 5XWD0. However, as of the academic year 2022-2023 course 5XWD0 is deleted from the curriculum and will not be taught anymore.

Electric and hybrid vehicles

Course descriptions

5XWC0 - Energy Management
This course deals with modelling, optimisation and supervisory control in hybrid and electrical vehicles. The students will be attending lectures on modelling, optimisation and control, and the developed theory will be used in two assignments, teaching how control theory is applied in automotive systems.

Learning Outcomes
1. Derive models for energy management of the main energy producers/consumers in a vehicle
2. Motivate the need for energy management systems in hybrid and electrical vehicles
3. Identify, formulate and solve simple optimisation problems
4. Formulate control and estimation problems as optimisation problems
5. Develop an optimisation-based energy management system for a hybrid electrical vehicle
6. Develop a simple battery monitoring system that estimates its remaining charge

Course Content
The course will be a combination of theory on modelling, optimisation and control, and the application of these techniques in hybrid and electrical vehicles. In particular, the lectures will treat the following topics:
1. Modelling of powertrain components and vehicle dynamics for energy management
2. Introduction to optimisation problems and conditions for optimality
3. Constrained convex optimisation and algorithms for solving optimisation problems
4. Optimal control, optimal parameter estimation and optimal state estimation

These topics will be applied in the following two assignments:
1. Power split control of hybrid electrical vehicles
2. State of charge estimation of batteries

Course Material
Will be made available through CANVAS

Responsible Lecturer
dr.ir. M.C.F. Donkers

5WXB0 - Electric Drive Systems
The objective of this course is to familiarize the students with electrical drives for numerous applications. The course uses an electric-vehicle powertrain as the benchmark application.

Learning Outcomes
Participants in this course are expected to learn the steady-state and transient modelling of modern electrical drives. The students should be able to create and use equivalent schemes of electromechanical components in order to analyse existing and new electrical powertrain solutions. Finally, they should be able to understand modern control methods of electrical drives.
After this course, the students will be familiar with virtually all commonly-used types of electrical motors and power-electronic converters as well as control methods in electrical drive systems. The course will prepare them to embark on a career in the area of electrical drives. Moreover, it will prepare the students for a high-level R&D in this engineering field.

Course Content
The course addresses aspects of mechanics, electromechanics, modelling and control, power electronics and battery systems relevant for modern electrical drive systems.
The classical (brush) DC motor/generator and state of the art permanent magnet machine will be used to illustrate the theory.

Electric and hybrid vehicles

Speed and torque control of a motor/generator combination will be treated during lectures and instructions, and applied in a laboratory set-up. The laboratory experiments need to be reported, this report (5XWB2 assignment) is graded separately.

Prior Knowledge

Prior knowledge of energy, electric motors, power electronics and control theory at the undergraduate level is expected:

- 5ESD0 – Control Systems
- 5APA0 - Power electronics

Course Material

R Krishnan, Permanent Magnet Synchronous and Brushless DC Motor Drives, 2010.

Responsible Lecturer

dr.ir. H. Huisman