

## Vehicle Powertrain Systems

Code: MK3GEPEJ06JG20-EN

ECTS Credit Points: 6

Evaluation: mid-semester grade

Semester: 5<sup>th</sup> semester

Its prerequisite(s): Vehicle and Drive Elements II

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 4+2

### Topics:

Review of the elements of the different power train systems from the engine to the driven wheels. The task of the drive train systems and their effects on the drive dynamic. The power need of the vehicle and power train concepts.

Clutches and couplings: construction of the mechanical and hydrodynamic clutches. Actuating and controlling the clutch; calculating forces and torques; force diagram; dual-mass flywheel.

Transmissions: tasks and main types of them, grouping. Manual transmission, planetary gear. Hydrodynamic torque transformer; continuous variable transmissions. Automatic transmissions, kinematic relationship. Retarders; external synchronous clutches; transmission actuators. Special transmissions: CVT, DCT, toroid.

Drive of wheels: cardan shaft; transfer case; differentials. Four wheel and all-wheel drive systems.

Modelling and calculating procedures, set up of vehicle model: gear assignment, static characteristics. Modelling the power transmission, related vehicle dynamic model.

Synchronous clutches, switching process and its forces (forced synchronous clutch). Heavy commercial vehicle's AMT inspection. Modelling the pneumatic transmission actuator. Calculation of the hydrodynamic coupling and torque transformer. Kinematic and dynamic correlations of planetary gears. AT switching schemas, torque distribution, diagnostic methods of the mechatronics components. Selection, and seizing of electric motors and batteries. Energy management of hybrid drive systems. Set up of the control circuit (charging-control, recuperation, energy release).

Laboratory and measuring:

Disassemble and assemble of power transmission units. Measuring clutches and transmissions on test bench.

Vehicle test stand measuring: recording tractive force diagram, power utilization, testing the effects of modifying the differential parameters. Writing measuring report of the tests.

### Literature:

*Compulsory:*

- David Crolla, Behrooz Mashadi: Vehicle Powertrain Systems. 2011. ISBN-13: 978-0470666029
- Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi: Modern Electric, Hybrid Electric, and Fuel Cell Vehicles. 2004. ISBN-0-8493-3154-4
- Ferit Küçükay, Burkhard Pollak, Gunter Jürgens, Rolf Najork, Robert Fischer: The Automotive Transmission Book. 2015. ISBN 978-3-319-05263-2

*Recommended:*

- Naunheimer, H., Bertsche, B., Ryborz, J., Novak, W.: Automotive Transmissions. 2011. ISBN 978-3-642-16214-5

## Schedule

### 1<sup>st</sup> week Registration week

#### 2<sup>nd</sup> week:

**Lecture:** elements of the different power train systems from the engine to the driven wheels. Clutches and couplings: construction of the mechanical and hydrodynamic clutches.

**Practice:** The power need of the vehicle and power train concepts. Actuating and controlling the clutch; calculating forces and torques; force diagram; dual-mass flywheel.

#### 4<sup>th</sup> week:

**Lecture:** Drive of wheels: cardan shaft; transfer case; differentials. Four wheel and all-wheel drive systems.

**Practice:** Modelling and calculating procedures, set up of vehicle model: gear assignment, static characteristics. Modeling the power transmission, related vehicle dynamic model.

#### 6<sup>th</sup> week:

**Lecture:** Heavy commercial vehicle's AMT inspection. Modeling the pneumatic transmission actuator.

**Practice:** Calculation of the hydrodynamic coupling and torque transformer.

### 8<sup>th</sup> week: Mid-term test

#### 9<sup>th</sup> week:

**Lecture:** AT switching schemas, torque distribution, diagnostic methods of the mechatronics components.

**Practice:**

#### 11<sup>th</sup> week:

**Lecture:** Kinematic and dynamic correlations of planetary gears.

**Practice:** Disassemble and assemble of power transmission units.

#### 13<sup>th</sup> week:

**Lecture:** Energy management of hybrid drive systems I.

#### 3<sup>rd</sup> week:

**Lecture:** Transmissions: tasks and main types of them, grouping. Manual transmission, planetary gear. Hydrodynamic torque transformer; continuous variable transmissions.

**Practice:** Automatic transmissions, kinematic relationship. Retarders; external synchronous clutches; transmission actuators. Special transmissions: CVT, DCT, toroid.

#### 5<sup>th</sup> week:

**Lecture:** Synchronous clutches, switching process and its forces (forced synchronous clutch).

**Practice:** Assembling different types of synchronous clutches

#### 7<sup>th</sup> week:

**Lecture:** Kinematic and dynamic correlations of planetary gears I.

**Practice:** Calculating the kinematic ratios of planetary gears.

#### 10<sup>th</sup> week:

**Lecture:** Set up of the control circuit (charging-control, recuperation, energy release).

**Practice:** Charging-control, recuperation, energy release.

#### 12<sup>th</sup> week:

**Lecture:** Selection, and seizing of electric motors and batteries.

**Practice:** Measuring clutches and transmissions on test bench

#### 14<sup>th</sup> week:

**Lecture:** Energy management of hybrid drive systems II.

**Practice:** Vehicle test stand measuring: recording tractive force diagram, power utilization, testing the effects of modifying the differential parameters.

**Practice:** Writing measuring report of the tests.

### 15<sup>th</sup> week: End-term test

## Requirements

### A, for a signature:

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice classes** is compulsory. Students must attend the practice classes and may not miss more than three of the during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students cannot make up practice classes with another group. Attendance at practices will be recorded by the practice leader. Being late is equivalent with an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, being discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments for the course with them to each practice class. Active participation is evaluated by the teacher in every class. If a student's behavior or conduct doesn't meet the requirements of active participation, the teacher may evaluate their participation as an absence because of the lack of active participation in class.

Students have to **take part in laboratory measures** and submit the measuring reports minimum on a sufficient level.

During the semester there are two tests: the mid-term test in the 8<sup>th</sup> week and the end-term test in the 15<sup>th</sup> week. Students have to sit for the tests.

### B, for a grade:

The course ends with an **examination**. Based on the average of the grades of the measuring reports and the examination, the exam grade is calculated as an average of them:

- the average grade of the measuring reports
- the result of the examination

The minimum requirement for the mid-term and end-term tests and the examination respectively is 60%. Based on the score of the tests separately, the grade for the tests and the examination is given according to the following table:

Score	Grade
0-59	fail (1)
60-69	pass (2)
70-79	satisfactory (3)
80-89	good (4)
90-100	excellent (5)

If the score of any test is below 60, students can take a retake test in conformity with the EDUCATION AND EXAMINATION RULES AND REGULATIONS.