

Automotive Electronics and Mechatronics

Code: MK3GEELJ04JG20-EN

ECTS Credit Points: 4

Evaluation: exam

Semester: 5th semester

Its prerequisite(s): Electronics and Electrotechnics

Further courses are built on it: Yes/No

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

Topics:

Basics of electronics: DC resistive networks and their calculation; periodic signals and their description, modulation methods. Passive electronic components (resistors, capacitors, inductive components) and their technology. Other electrical components (switches, push buttons, connectors, cables) and their manufacturing technology. Simplest semiconductors and manufacturing technologies. Construction, operation and application of diodes and bipolar transistors. Basic connections with semiconductors: diode switches, switching operation of transistors. Integrated circuits and their manufacturing technology. Electronic sensors, electric actuators (relays, electromagnets, motors). Wired communication protocols. Structure, operation and adaptation of memories and mass storage. Construction and operation of microprocessors and microcontrollers. Construction of control units, wiring diagrams with application examples. Electrology: warming of direct current networks, transients of RLC circuits, alternating current networks, basics of signal processing. Semiconductors (FET, IGBT, Thyristor, Triac). Electronic circuits: operational amplifiers, filters, timers, frequency generators. References, power supplies, stabilizers, inverters. Combination and sequence networks, FPGAs: basic elements of logical networks, application technology. Sensors: thermocouples, piezo sensors, magnetostatic, magneto resistive, optical, surface physics, MEMS. Actuators: piezo-electric, pyrotechnic, thermodynamic, magnetostrictive, electrostatic, MEMS. Programming languages, software development. Construction and programming of PLCs. Displays, touch screens. Elements, batteries, super capacities, fuel cells design, construction, main properties. Automotive electronic measuring instruments.

Literature:

Compulsory:

- B.T. Fijalkowski: Automotie Mechatronics: Operational and Practical Issues, Springer, 2011., ISBN 978-94-007-0408-4
- Robert Bosch GmbH: Autoelektrik/Autoelektronik, Springer, 2007., ISBN 978-3-322-91560-3
- Allan W. M. Bonnicksen: Automotive Computer Controlled Systems. Elsevier, 2001.
- Cetinkunt: Mechatronics. Wiley, 2005.
- R., Konrad: Automotive Mechatronics: Automotive Networking, Driving Stability Systems, Electronics, Springer, 2015., ISBN 978-3-658-03974-5

Schedule

1st week Registration week

2nd week:

Lecture: The vehicle as a complex mechatronic system. Development, trends. SAE J1850 Protocol, IEEE 1394 Protocol, switches, buttons. Vehicle overview. Basics of Vehicle Dynamics.

Practice: General description about laboratory regulations. Accident prevention and safety education. Transients in DC

3rd week:

Lecture: Structure of vehicle drive chains. Controller Area Networking, CAN Arbitration, CAN Error Detection, CAN Architecture, FPGA

Practice: Main parts of engine controller unit, actuators, controllers

circuits. Voltage boosting and lowering switching and application. (Ignition of petrol vehicles).

4th week:

Lecture: Electricity supply to vehicles on board. Electricity network construction. Protections. Actuators

Practice: Vehicle diagnostics, Bus systems.

6th week:

Lecture: Vehicle actuators and controls.

Practice: Actuator and control simulation in software environment

8th week: Mid-term test

9th week:

Lecture: Vehicle braking systems as mechatronic systems. (ABS / ESP / ESR), OBD systems and self-diagnostic systems

Practice: Operation of ABS/ESC

11th week:

Lecture: Examples of driver assistance systems. Information about the external environment. Radar, ultrasound, laser and camera in vehicles. Parking and parking assist system. Automatic speed and distance control (ACC).

Practice: Measurement of LED characteristics, Measurement of an optical gate, Measuring of an ultrasonic distance sensor, Ultrasonic sensors. Their structures, working principles, characteristics, and application areas.

13th week:

Lecture: Examples of mechatronics for comfort and security systems. Air-conditioning. Main elements of cooling / heating / ventilation system. Central locking.

5th week:

Lecture: Fundamentals of bus systems, Construction in vehicles. Types, their main characteristics. EMC and ESD in vehicles.

Practice: EMC Simulation elements.

7th week:

Lecture: Sensor and actuator elements for motor controllers. Fuel pumps, Semiconductors (FET, IGBT, Thyristor, Triac) Transmission systems. Automotive Vehicle Driving Performance

Practice: Fuel pumps simulation, errors, error detection. Analysis of intelligent shifting, simulations

10th week:

Lecture: Monitoring of vehicle length and transverse dynamics, stability. Suspensions. Half active and active damping. Power steering. Governance strategies. Global body control.

Practice: Vehicle dynamics calculations and simulations

12th week:

Lecture: Examples of passenger and driver safety. Tire pressure check Airbag. Automatic belt tensioners.

Practice: Pressure calculation, type of sensors, safety regulations.

14th week:

Lecture: Examples of mechatronics for comfort and security systems. Window and headlight washers. Windows. Active lighting system - Automatic adjustment. Fleet management, self-driving and

Practice: Basics of comfort theorem, ergonomics, calculations

autonomous vehicles, levels of autonomous systems

Practice: Demonstrate on intelligent lighting table, Case studies

15th week: End-term test

Requirements

A, for 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 times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't make up a practice with another group. Attendance at practice classes will be recorded by the practice leader. Being late is counted as 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, to be discussed with the tutor. 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 his/her participation as an absence due to the lack of active participation in class.

During the semester there is some homework related to each topic and there are two tests: the mid-term test is in the 7th week and the end-term test in the 15th week. Conditions for the signature:

- to reach the 50 % score on both tests.
- to hand in the home assignments in time.

B, for a grade:

The course ends with a **mid-semester grade (AW5)**. During the exam period there is another test on all the topics of the semester. This test is accepted with minimum 50 % score. The total score of the semester is the sum of the scores of all tests (mid-term, end-term, exam) and the homework tasks, and the grade is given according to the following table:

Score	Grade
0-99	fail (1)
100-129	pass (2)
130-159	satisfactory (3)
160-179	good (4)
180-200	excellent (5)