COURSE DESCRIPTION CARD - SYLLABUS

Course name
Mechatronic control of vehicle systems

Course

Field of study
Mechatronics
Area of study (specialization)
Mechatronic design of machines and vehicles
Level of study
Second-cycle studies
Form of study
full-time

Year/Semester
2/3
Profile of study
general academic
Course offered in
Polish
Requirements
elective

Number of hours

Lecture
15
Laboratory classes
15
Other (e.g. online)
Tutorials
Projects/seminars

Number of credit points

2

Lecturers

Responsible for the course/lecturer:
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Prerequisites

Knowledge: He knows the knowledge of technical mechanics and knows structure and methods designing vehicles. He knows the basics of modeling physical systems.

Skills: Is able to use the following languages: native and international to a degree enabling the understanding of technical texts. He can obtain information from literature, the Internet, databases and other sources. Can integrate the obtained information, interpret and draw conclusions from it, and create and justify opinions. He can use learned mathematical theories to create and analyze simple mathematical models of vehicle dynamics.

Social competences: Understands the need and knows the possibilities of continuous training.

Course objective

The aim of the course is to present knowledge on the application of the mechatronic structure of various vehicle subsystems, paying attention to the purpose of mechatronization of the discussed systems (extension of functionality and optimization of functioning, increase of energy efficiency, increase of safety). Overview of the sensors, actuators and control algorithms used. Acquainting with models of controlled processes and used components.

Course-related learning outcomes

Knowledge

1. Knows the current state of use of mechatronics in the discussed vehicle subsystems [K2_W16].

2. Has knowledge of the methods of modeling and simulating processes controlled with the use of mechatronic systems [K2_W09].

Skills

1. Can describe the processes controlled in the mechatronic subsystems of vehicles, used sensors, actuators and control algorithms [K2_U01].

2. Is able to build simulation models allowing for design work on the discussed vehicle subsystems [K2_U14, K2_U03].

Social competences

1. Understands the areas of cooperation with the constructors of vehicle components [K2_K03].

2. Is aware of the importance and understanding of non-technical aspects and effects of engineering activities, including its impact on the environment and the related responsibility for decisions [K2_K02].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: Written exam - test and descriptive questions. Passing at least 50% of points. Each question is scored from 0 to 1 point.

Laboratory: assessment based on the results of the current control of preparation for classes and reports on the exercises performed.

Programme content

LECTURES:

Lecture 1 - Mechatronics in steering systems.

Electrohydraulic and electromechanical power steering. Power steering characteristics, speed dependence. Torque sensors and the methods of adjusting the assist force or characteristics used.

Lecture 2 - Mechatronics in controlling heating, ventilation and air conditioning

Criteria for assessing climatic comfort. Structure of HVAC (Heating, Ventilation and Air Condition), structure of air mixers. Temperature and ventilation control. Defrosting and demisting. Automatic control of HVAC systems. Applied sensors and actuators.

Lecture 3 - Mechatronics in controlling air suspensions

Structure of conventional and electropneumatic suspension for commercial vehicles. Basic components and their characteristics. The essence of ground clearance (body-axle) adjustment and air suspension leveling. Modeling of the air suspension system.

Lecture 4 - Mechatronics in parking assist systems (parking distance control). The structure of parking assist systems, sensors used (ultrasonic, laser, vision, steering wheel angle), rack-assisted electric power steering. Overview of parking assist systems (PARKTRONIC, Bosch parking assist etc.). Steering system control, communication with the user. Parking algorithms.

Lecture 5 - Mechatronics in passive safety systems -

SRS systems (Supplemental Restraint System) and the essence of their operation. Systems structure and characteristics of basic components - safety sensors and crash sensors, pyrotechnic and hybrid gas generators, multi-stage generators. Control algorithms for single and multi-stage systems (multistage). Detection of the protected person's position. Pyrotechnic and electromechanical seatbelt pretensioners.

Lecture 6 - Mechatronics in vehicle seats.

Structure and functions of car seats. Comfort in a sitting position and climatic comfort. Seat ergonomics and adjustment ranges. Seat adjustment mechanisms and electric adjustment drives. Memory of seat position and adjustment settings and automatic seat adjustment. Applied drives, sensors and control systems.

Lecture 7 - Mechatronics in the control of autonomous vehicles

SAE vehicle autonomy levels. Basic tasks of the autonomous vehicle control system - simultaneous location and mapping (SLAM) and with the use of multiple sensors and redundancy of acquired information. Structure and operation of basic sensors - vision sensors (mono and stereoscopic cameras),

lidar, distance sensors, radars; use of existing vehicle dynamics control systems and assistance systems (ADAS - Advanced Driver Assistance Systems).

Lecture 8 - Vehicle Communication Buses

Architecture of the vehicle information network: K-Line bus, CAN bus, LIN networks, FlexRay, MOST. Wireless transmission - GSM, GPRS, LTE packet data transmission, Bluetooth radio interface.

LABORATORIES:

Laboratory 1 - Modeling / testing of electric power steering gear

Laboratory 2 - Modeling / testing of the ventilation, heating and air conditioning control system (HVAC system)

Laboratory 3 - Modeling / testing of the ECAS (Electronically Controlled Air Suspension) system

Laboratory 4 - Modeling / testing of the automatic parking system

Laboratory 5 - Modeling / testing of the protected occupant position monitoring system.

Laboratory 6 - Modeling / testing of the seat adjustment control system.

Laboratory 7 - Modeling / testing communication in the CAN bus

Teaching methods

Lecture - information lecture method: lecture with multimedia presentation.

Laboratory - laboratory (experiment) method: laboratory exercises using Matlab / Simulink or SciLab / Xcos systems and teaching stations.

Bibliography

Basic

1. Ambroszko W. Układy mechatroniczne w pojazdach - przykłady. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław 2013,

2. Kuranowski A., Mirska-Świętek M.:Urządzenia wspomagające w pojazdach samochodowych: laboratorium, Wydawnictwo Politechniki Krakowskiej, 2011

3. Reif, K.: Automotive Mechatronics Automotive Networking, Driving Stability Systems, Electronics, Springer 2015.

4. Fryśkowski B., Grzejszczyk E.: Systemy transmisji danych, WKiŁ, 2010

Additional

1. BOSCH, Safety, Comfort and Convenience Systems 3rd Edition, Willey, 2007

2. Morello L., Rossini L. R., Pia G., Tonoli A.: The Automotive Body, Volume I: Components Design, Springer 2011

3. Morello L., Rossini L. R., Pia G., Tonoli A.: The Automotive Body, Volume II: System Design, Springer 2011

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2,0
Classes requiring direct contact with the teacher	30	1,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	20	1,0

[1] delete or add other activities as appropriate