COURSE DESCRIPTION CARD - SYLLABUS

Course name

Autonomous vehicles control systems

Course

Field of study	Year/Semester
Mechanical and Automotive Engineering	3/6
Area of study (specialization)	Profile of study
Autonomous vehicles	general academic
Level of study	Course offered in
First-cycle studies	polish
Form of study	Requirements
part-time	elective

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
18	9	0
Tutorials	Projects/seminars	
0	0	

Number of credit points

3

Lecturers

Responsible for the course/lecturer:

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Responsible for the course/lecturer:

Prerequisites

Knowledge:The student has knowledge of vehicle dynamics fundamentals and vehicle dynamics simulation methods. The student has knowledge of fundamentals of control theory.

Skills: The student Is able use the languages: native and international at a level sufficient to enable understanding of technical texts. Is able to obtain information from the literature, internet, databases and other sources. Can integrate the information to interpret and learn from them, create and justify opinions. The student is able to use learned mathematical and physical theories to build and analyze of simple mathematical models of vehicle dynamics.

Social competencies: Understands the need and knows the possibilities of lifelong learning..

Course objective

This course is designed to provide the student with knowledge of physical principles of processes control in motor vehicles, also autonomous vehicles. The second objective of the course is to learn state of the art in automotive control systems and future trends.

Course-related learning outcomes

Knowledge

1. Has knowledge of fundamentals of vehicle dynamics control and automated driving

2. Has knowledge of physical fundamentals of autonomous vehicle dynamics processes controlled by commonly used mechatronic vehicle control systems

Skills

1. Is able to analyze of operation of fundamental autonomous vehicle dynamics control systems used in autonomous cars with use of computer simulation tools

2. Is able to judge role and importance of particular elements of technical solutions of control systems used in modern cars to diagnose their operation

3. Is able to properly evaluate capabilities and limitation of fundamental control systems used in cars (especially concerning active safety systems)

Social competences

1. Is aware of the importance of usage of mechatronic control systems in modern vehicles

2. Is aware of the importance of design process of control system and the importance of realization of control algorithms for operation effectiveness of particular vehicle subsystems

3. Is aware of necessity of the possession of reliable and detailed knowledge of controlled processes for obtaining desired control goals

4. Is aware of the importance of basing on knowledge of various science and technology disciplines in designing of modern vehicles, causing that they are multidisciplinary products

5. Is aware of capabilities and limitation of control systems used in cars

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Written test, which is based on answers related to the selection of given answers and open questions. Credits will be given after achieving at least 50% of points. Answers are scores from 0 to 1 point.

Programme content

History, current state and development prospects of autonomous vehicles. Vehicle autonomy levels (from 0 to 5 according to NHTSA / SAE) - definitions and examples, advanced driver assistance systems - overview and definition of the main functions - examples of market presence.

Tasks of autonomous vehicle control systems - perception of the environment (detection, classification and tracking of objects), location and mapping of the environment, maneuver planning, maneuver implementation - braking control, acceleration, speed and direction of movement and its change.

Technologies relevant to autonomous vehicles - used for the perception of the environment - external cameras, lidar, front and rear radars, ultrasonic sensors,technologies for monitoring sleepiness and attention (e.g. internal cameras), technologies for data integration and processing - artificial intelligence (AI), large processing data sets (Big Data), machine learning systems, image recognition systems (machine vision), Internet of Things (IoT), communication networks and technologies (e.g. 5G, V2X), satellite location and navigation systems, HD maps - precise and dynamic digital maps.

Control systems in traditional vehicles - areas of use. Longitudinal dynamics control systems - ABS and ASR, automatic transmission control, cruise control, lateral dynamics control - ESP, parking aid, vertical dynamics control - adaptive and active suspensions.

Control systems used at different levels of autonomy: adaptive cruise control plus stop-and-go function, automatic emergency braking (including vehicle, pedestrian and cyclist detection), lane departure warning and lane-keeping systems, automatic lane change systems and cross-wind stabilization systems, automatic vehicle driving and parking in a parking lot, road sign recognition systems, monitoring of blind spots, night vision systems, driver drowsiness detection and driver attention detection, automatic adaptive light adjustment, navigation.

Assistance technologies and challenges for autonomous vehicles - 5G and V2X communication (vehicle to vehicle and vehicle to infrastructure), challenges for autonomous vehicles - costs, problems of interference between vehicles, resistance to weather conditions, urban traffic conditions.

Teaching methods

1. Lecture with a multimedia presentation - a combination of an information and problem lecture;

2. Laboratory exercises with the use of Matlab / Simulink systems, dSpace and laboratory stands of varoious vehicle control systems (ABS, semiactive shock absorber, auttoatic transmission)

Bibliography

Basic

1. Reński A.: Bezpieczeństwo czynne samochodu. Zawieszenia oraz układy hamulcowe i kierownicze. Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2011

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

3. Kozłowski M., Choromański W., Grabarek I. , Czerepicki A., Marczuk K. :Pojazdy autonomiczne i systemy transportu autonomicznego, Wydawnictwo Naukowe PWN, Warszawa 2020

Additional

1. Bosch Automotive Handbook ?8th edition, Bentley Publishers, 2010

2. Rajamani R.: Vehicle Dynamics and Control, Springer 2012

3. Savaresi S., Poussot-Vassal Ch.,Spelta C. Sename O., Dugard L. :Semi-Active Suspension Control Design for Vehicles, Butterworth-Heinemann, 2010

4. Ślaski G.: Studium projektowania zawieszeń samochodowych o zmiennym tłumieniu, Wydawnictwo Politechniki Poznańskiej, Rozprawy. Nr 481. ISSN 0551-6528, Poznań 2012

5. Watzenig D. Horn M.: Automated Driving - Safer and More Efficient Future Driving, Springer International Publishing 2017

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,0
Classes requiring direct contact with the teacher	27	1,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	48	2,0

[1] delete or add other activities as appropriate