



## COURSE DESCRIPTION CARD - SYLLABUS

Course name

Autonomous Vehicles

### Course

Field of study

Automatic Control and Robotics

Area of study (specialization)

Vision systems

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

compulsory

### Number of hours

Lecture

15

Laboratory classes

0

Other (e.g. online)

0

Tutorials

0

Projects/seminars

15

### Number of credit points

0

### Lecturers

Responsible for the course/lecturer:

dr inż. Julian Balcerek

Responsible for the course/lecturer:

email: julian.balcerek@put.poznan.pl

phone: 61 647 5936

Faculty of Control, Robotics and Electrical  
Engineering

Piotrowo 3A, 60-965 Poznan, Poland

### Prerequisites

Knowledge: Students starting this course should have knowledge of the basics of programming, digital signal processing, human-robot interfaces, and artificial intelligence and biometrics.

Skills: Should have the ability to solve basic problems of signal processing using high-level programming language and the ability to obtain information from specified sources and be ready to cooperate within a team.



Social competences: In addition, in the area of social competences, the student must exhibit such qualities as honesty, responsibility, perseverance, cognitive curiosity, creativity, personal culture, respect for other people.

### Course objective

1. Providing students with basic knowledge about autonomous vehicles, necessary for the proper design, use and implementation of systems for autonomous vehicles.
2. Developing students' ability to solve problems arising when designing systems for autonomous vehicles.
3. Developing students' teamwork skills and using software to design systems for autonomous vehicles.

### Course-related learning outcomes

#### Knowledge

1. Has ordered and in-depth knowledge in the field of artificial intelligence methods and their applications in automatic control and robotics systems for autonomous vehicles [K2\_W2].
2. Has detailed knowledge of the construction and use of advanced sensory systems in autonomous vehicles [K2\_W6].
3. Has knowledge of development trends and the most important new achievements in the field of automatic control and robotics for autonomous vehicles and related scientific disciplines [K2\_W12].

#### Skills

1. Is able to analyze and interpret project technical documentation and use scientific literature related to a given problem [K2\_U2].
2. Is able to use advanced methods of signal processing and analysis, including vision signal and extract information from the analyzed signals [K2\_U11].
3. Is able to select and integrate elements of a specialized measuring and control system including: control unit, executive system, measuring system and peripheral and communication modules [K2\_U13].
4. Can formulate and solve tasks involving the design of automatic control and robotics systems for autonomous vehicles to see their non-technical aspects, including environmental, economic and legal [K2\_U14].

#### Social competences

1. Is aware of the importance and understands the non-technical aspects and effects of engineering activities, including its impact on the environment and the associated responsibility for decisions; is ready to develop his professional achievements [K2\_K2].



2. Is aware of the need for a professional approach to technical issues, meticulous familiarization with the documentation and environmental conditions in which the devices and their elements can function [K2\_K4].

### Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Formative assessment:

a) in the scope of lectures:

based on answers to questions about the material discussed in previous lectures,

b) in the scope of project classes:

based on an assessment of the current progress of tasks and on the basis of two presentations made independently by each team of students.

Summative rating:

a) in the scope of lectures, verification of assumed learning outcomes is carried out by:

- i. assessment of knowledge and skills demonstrated at the test - written essay of a problem nature; scoring 50% of points means a positive grade,
- ii. discussion of the results of the test,

b) in the scope of project classes, verification of assumed learning outcomes is carried out by:

- i. assessment of knowledge and skills related to the implementation of project tasks; this assessment also includes teamwork skills,
- ii. student's assessment and "defense" of the project implementation report.

Obtaining additional points for activity during classes, in particular for:

- i. discussion about additional aspects of the issue,
- ii. effectiveness of applying the acquired knowledge while solving a given problem,
- iii. ability to cooperate within a team that practically implements a project task,
- iv. comments related to the improvement of teaching materials,
- v. indicating students' perceptual difficulties, enabling ongoing improvement of the didactic process.

### Programme content

The lecture program includes the following topics:



1. Automation of vehicles - history and features of autonomous vehicles, classification according to levels of automation, physical model of the vehicle, selected types, constructions and applications of vehicles.
2. Vehicle environment sensors - radar, lidar, ultrasonic, vision, stereovision, thermovision, sound, pressure, strain gauge, thermometer, hygrometer, accelerometer, gyroscope, magnetometer, satellite navigation system receiver, maps of the environment.
3. Automatic perception of the environment based on vision signal processing - traffic planning, control and decision making, classification efficiency parameters, mono- and stereo vision systems, recognition of the type and condition of the road surface, detection of road lines, recognition of road signs and traffic lights, recognition and tracking of threat objects, virtual exterior mirror, 360 degree camera system, night driving support.
4. Communication of vehicles with external devices - communication with road infrastructure, with other vehicles, with the network, with mobile devices and with a power source, data protection.
5. Interaction of vehicles with the user - transferring information to the user: liquid crystal display, head-up display, augmented reality, autostereoscopic screen, sounds and vibrations; reading the user's physical state and emotions, user control options, advanced voice prompts, gesture control, brain-computer interface, creating favorable conditions for the user, vehicles personalization, body protection during danger.
6. Direct transmission of signals from the vehicle to the environment - variable light beam, external displays, thermosensitive and electrochromic varnishes, sound signals, ultrasound emission, external direct protection systems.
7. Plans for the development of autonomous vehicles - circumstances favoring and slowing down the development, solutions for users of older vehicles, selected regulations and a summary.

During the project classes, tasks related to autonomous vehicles are carried out. The subject and scope of each project is determined individually, usually with particular emphasis on data preparation, software implementation and performance tests. Projects are usually implemented in groups of 2/3 people throughout the whole term.

### Teaching methods

1. Lecture: multimedia presentation, presentation illustrated with examples given on a board, problem solving, multimedia show, demonstration.
2. Project: multimedia presentations, discussion, teamwork.

### Bibliography

Basic

1. Roland Siegwart and Illah R. Nourbakhsh, Introduction to autonomous mobile robots, A Bradford Book, The MIT Press, Cambridge, Massachusetts, London 2004.



2. Farbod Fahimi, Autonomous robots : modeling, path planning, and control, Springer, New York 2009.
3. Cezary Szczepaniak, Podstawy modelowania systemu: człowiek-pojazd-otoczenie, Wydawnictwo Naukowe PWN, Warszawa, Łódź 1999.
4. Janusz Sobieraj, Rewolucja przemysłowa 4.0, Wydawnictwo Naukowe Instytutu Technologii Eksploatacji - Państwowego Instytutu Badawczego, Radom 2018.

Additional

1. Jerzy Merkisz, Ireneusz Pielecha, Układy elektryczne pojazdów hybrydowych, Wydawnictwo Politechniki Poznańskiej, Poznań 2015.
2. Jerzy Merkisz, Ireneusz Pielecha, Układy mechaniczne pojazdów hybrydowych, Wydawnictwo Politechniki Poznańskiej, Poznań 2015.
3. Bogumił Fic, Samochody elektryczne, Wydawnictwo i Handel Książkami "KaBe", Krosno 2019.

**Breakdown of average student's workload**

	Hours	ECTS
Total workload	60	0
Classes requiring direct contact with the teacher	30	0
Student's own work (literature studies, preparation for project classes, preparation for test, presentations preparation, project preparation) <sup>1</sup>	30	0

<sup>1</sup> delete or add other activities as appropriate