COURSE DESCRIPTION CARD - SYLLABUS

Course name
Soft Robotics [S2AiR2-ISAiR>MR]

Course

Field of study
Automatic Control and Robotics

Year/Semester
1/2

Area of study (specialization)
Intelligent Control and Robotic Systems

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
30

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

dr hab. inż. Jakub Bernat
jakub.bernat@put.poznan.pl

Lecturers

Prerequisites

Knowledge: The student should have knowledge of automation and robotics, in particular issues related to robot modeling, automation actuators, pneumatics and control systems. Should know the basics of machine learning. A student starting this subject should have basic knowledge of mathematics and programming. Skills: The student should have the ability to program and simulate dynamic systems. The student should have the ability to obtain information from literature. Student should have the ability to actively participate in organized lectures for a large group of people, be aware of the need to expand theoretical and practical knowledge and constantly update acquired knowledge due to dynamic technological and changes in modern technology. Social Competences: The student should also understand the need to expand their competences and constantly update the acquired theoretical and practical knowledge due to the dynamic development of modern technology. Student should be ready to cooperate as part of a team carrying out a laboratory exercise or a joint project.

Course objective

Course objective is to provide students with basic knowledge of soft robotics. Determination of the basic properties of materials used in soft robotics and discussion of typical configurations and applications of soft robots. In addition, presentation of methods for designing soft actuators and sensors. Discussion of the issues of modeling soft systems. Presentation of the method of describing systems with continuous geometry. Presentation of control methods for the above-mentioned systems, including issues related to machine learning..

Course-related learning outcomes

Knowledge
Student has a knowledge of soft robotics and their application in automation and robotics systems.
Skills
Student is able to design and implement the soft robotics systems. Student is able to use advanced programs to support project design and is able to solve engineering tasks.
Social competences
Student is aware of the need for a professional approach to technical issues, familiarization with the documentation and environmental conditions in which the devices and their components can function;
Student is ready to comply with the principles of professional ethics and to require this from others, respecting the diversity of views and cultures.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

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Rating:
a) in the scope of lectures, verification of learning outcomes is carried out by:
assessment of knowledge and skills demonstrated during the written exam (3 questions, 10 points per question).
b) in the scope of laboratories - grade based on the project performed by student (or group of students).

Assessment rules (for passing the lecture and tutorials):
3.0 at least 50% points,
3.5 at least 60% points,
4.0 at least 70% points,
4.5 at least 80% points,
5.0 at least 90% points.

Programme content

The lecture presents subjects related to soft robotics. The key programme includes an overview of the concept of soft robots, a presentation of materials used in soft robotics, and a discussion of the principles of modelling and controlling soft robots.

Course topics

The lecture program covers the following topics:
1. Presentation of the issues of soft robotics. The impact of the latest achievements in soft robotics on automation and robotics.
2. Determination of the key phenomena occurring in the issues of soft robotics, in particular the presentation of materials used in soft robots.
3. Fundamentals of designing soft robot elements, discussion of design methods using the finite element method.
4. Modeling of soft robots. Overview of systems with continuous geometry.
5. Control of soft robots using models with continuous geometry and the use of machine learning methods to control robotic systems.

Laboratory classes are conducted in the form of 2-hour exercises, taking place in the laboratory, preceded by an instructional session at the beginning of the semester. In the first half of the semester, students carry out issues in the form of laboratory exercises. In the second half of the semester, students are given project

topics to be implemented as part of the exercises. Projects are carried out individually or in teams of two, depending on the expected difficulty of the project.

The laboratory program covers the following topics:
Selected problems and methods of designing soft robots, determining the static and dynamic properties of soft robots, designing control systems using machine learning. Some of the above-mentioned program content is implemented in the student's own work.

Teaching methods

Teaching methods:
1. lecture: multimedia presentation, example simulations.
2. laboratories: desigin and implemenation of soft robotics system.

Bibliography

Basic
1. Ian Goodfellow, Yoshua Benglo, Aaron Courville, Deep Learning systemy uczące się, PWN, 2018
2. Tadeusz Szkodny, Podstawy robotyki, Wydawnictwo Politechniki Śląskiej, 2012
Additional
1. Piotr Tatjewski, Sterowanie Zaawansowane obiektów przemysłowych – struktury i algortmy
2. R. S. Sutton and A. G. Barto, Reinforcement Learning – An introduction, The MIT Press, 2018
3. Feifei Chen and Michael Yu Wang, Design Optimization of Soft Robots - A Review of the State of the Art, IEEE Robotics & Automation Magazine, 2020
4. Daniela Rus, Michael T. Tolley, Design, fabrication and control of soft robots, Nature, Vol. 521, 2015

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00