COURSE DESCRIPTION CARD - SYLLABUS

Course name
Intelligent measurement and control systems [S2AiR2-ISA>ISPiS]

Course

Field of study
Automatic Control and Robotics

Year/Semester
2/3

Area of study (specialization)
Intelligent Control 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
30

Laboratory classes
30

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

3,00

Coordinators

dr inż. Przemysław Siwek
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Lecturers

Prerequisites

The student must have engineering competences (i.e. the title of professional engineer) and qualifications, i.e. knowledge, skills and competences defined in the field learning outcomes according to the Polish Qualification Framework (PRK 6) for the degree programme in the field of Automatics and Robotics at the Poznan University of Technology, with particular emphasis on the learning outcomes from the first degree programme in this field of study and a successfully completed two semesters of the second degree programme in the field of A and R, specialization ISA.

Course objective

The aim of the course is to familiarise students with intelligent control systems and measurement methods in industrial automation and electronics, especially in control and measurement systems and control of robot and drone drives.

Course-related learning outcomes

Knowledge:
K2_W2 has a structured and in-depth knowledge of artificial intelligence methods and their application in automation and robotics systems;

K2_W7 has an advanced and in-depth knowledge of methods of analysis and design of control systems;
K2_W12 has knowledge on development trends and most significant new achievements in the field of automation and robotics, and related scientific disciplines
K2_W18 has a structured and in-depth knowledge of specialised microprocessor systems designed for control and measurement systems;

Skills:
K2_U9 is able to simulate and analyse the operation of complex automation systems, and to plan and carry out experimental verification;
K2_U10 is able to determine models of simple systems and processes, and use them for the purpose of analysis and design of automation and robotics systems;
K2_U26 is able to construct an algorithm for solving a complex measurement and computation-control task, as well as implement, test and run it in a selected programming environment on a microprocessor platform;

Social competences:
K2_K4 is aware of the necessity of a professional approach to technical issues, scrupulous familiarisation with documentation and environmental conditions in which devices and their components may function;

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: the exam consists of a test in the form of a written response to a given question and a discussion (optional) on selected issue(s) with the explanation of written answers from the scope of the programme contents.
Laboratory classes: attendance at classes and performing laboratory exercises involving the programming of a control and measurement system in groups and individually, followed by a written report on the completed work.

Programme content

The aim of the course is to familiarise students with intelligent control systems and measurement methods in industrial automation and electronics, especially in control and measurement systems and control of robot and drone drives.

Course topics

General architecture of advanced control and measurement systems, and their interaction with the environment. Selected issues concerning A/C and D/A converters. Methods of measuring selected physical quantities: voltage, current, speed, position.
Fuzzy control systems (TSK), fuzzy sliding control systems, neural control systems, examples of neural network learning methods, control systems with optimization inspired by biological behavior (genetic algorithm, particle swarm, cuckoo),
Analysis of fuzzy and neural systems with one and two degrees of freedom UAR in structure with Smith predictor, IMC, 2DOF, MFC, MFC/IMC, 2DOF/IMC structure.
Analysis of NN MRAC systems, online and offline control, fuzzy and neural adaptive controllers
Application of reinforcement learning in speed and position control of highly dynamic systems

Laboratory exercises. The programme of laboratory exercises includes getting acquainted with the construction, commissioning and programming of an areopendulum-type laboratory system using artificial intelligence methods.

Teaching methods

Lecture
Lecture with multimedia presentation (including: drawings, photos, animations, sound, films) supplemented by examples given on the board. Initiating discussion during the lecture.
Laboratory.
Working in teams and team programming, carrying out tasks given by the teacher - practical exercises.

Bibliography

Basic:
1. Konrad Hejn, Antoni Leśniewski , Systemy Pomiarowe,Oficyna Wydawnicza Politechniki Warszawskiej, rok wydania: 2017, ilość stron: 270, ISBN: 978-83-7814-624-7
2. Nawrocki W. Komputerowe systemy pomiarowe, WKŁ, Warszawa 2006.
3. Kosiński Robert, Sztuczne sieci neuronowe, PWN 2018.
4. Giergiel Mariusz J., Zenon Hendzel, Wiesław Żylski , Modelowanie i sterowanie mobilnych robotów kołowych, PWN 2002
5. Skoczowski Stanisław, Osypiuk Rafał, Pietrusewicz Krzysztof, Odporna regulacja PID o dwóch stopniach swobody, PWN 2006
6. https://ch.mathworks.com/products/reinforcement-learning.html
7. https://ch.mathworks.com/products/fuzzy-logic.html
8. https://ch.mathworks.com/discovery/neural-network.html

Additional:
1.Pajchrowski T., Zawirski K., Nowopolski K., Neural Speed Controller Trained On-Line by Means of Modified RPROP Algorithm, IEEE Transactions on Industrial Informatics
2 Pajchrowski T,: Application of an Internal Model Speed Control for PMSM with variable mechanical parameters, Proceedings of 2015 IEE 2nd International Conference on Cybernetics CYBCONF, Gdynia, Poland, 24-26 June 2015.
3. Pajchrowski T,: Robust control of PMSM system using the structure of MFC, COMPEL: The International Journal for Computation and Mathematics in Electrical and Electronic Engineering, Vol. 30, nr. 3, s. 979-995, 2011
4. Pajchrowski T, Wójcik A., Siwek P, Adaptive controller design for electric drive with variable parameters by Reinforcement Learning method, Bulletin of the Polish Academy of Sciences. Technical Sciences, 2020.
5. Brock S., Łuczak D., Nowopolski K., Pajchrowski T., Zawirski K.: Two Approaches to Speed Control for Multi-Mass System With Variable Mechanical Parameters, IEEE Transactions on Industrial Electronics, VOL. 64, NO. 4, APRIL 20

Breakdown of average student's workload

	Hours	ECTS
Total workload	90	3,00
Classes requiring direct contact with the teacher	60	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00