COURSE DESCRIPTION CARD - SYLLABUS

Course name
Advanced process automation [S2AiR2-ISAiR>ZAP]

Course

Field of study
Automatic Control and Robotics

Year/Semester
1/1

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
30

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
15

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

A student beginning this course should have basic knowledge of the basics of automation, automatic control systems and control theory, as well as industrial controller programming. He or she should have the ability to solve basic problems while designing automatic control systems (selection of regulator settings, stability testing, selection of measuring sensors) and the ability to obtain information from indicated sources. He/she should also understand the necessity of broadening his/her competences / be ready to start cooperation within the team.

Course objective

1. To provide students with knowledge in the field of control techniques in process automation systems, in the description of control objects and the use of specialized control algorithms. 2. To develop students' skills in solving design problems concerning process automation control systems. 3. Developing in students the skills of teamwork in solving advanced control issues.

Course-related learning outcomes

Knowledge
1. has an orderly, theoretically based, detailed knowledge of methods of analysis and design of control

systems;
2. has an elementary knowledge of the operation and use of IT tools designed for rapid prototyping and design, simulation and visualization of automation systems and systems;
3. has knowledge of development trends and the most important new developments in the field of automation and related scientific disciplines;
4. has knowledge of basic criteria of controller synthesis and tuning methods, tools and techniques for selecting controller settings and identifying control objects;
5. has theoretical knowledge of process automation systems, possibilities of solving control problems in this area;
Skills
1. is able to apply the chosen regulation technique and adjust it to the properties of the object and the system of regulation;
2. is able to select parameters and settings of a basic industrial controller and to configure and program an industrial programmable controller;
3. is able to design and practically use simple diagnostic and decision making systems dedicated to automation systems;
4. is able to critically evaluate and select appropriate methods and tools to solve an automation task;
Social competences
1. understands that knowledge and skills in the module's subject matter must be supplemented;
2. is aware of responsibility for his/her own work and willingness to comply with the rules of teamwork;
3. is aware of the need for a professional approach to technical issues, scrupulous study of the documentation and the environmental conditions in which the equipment and its components can operate;

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

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Formulation evaluation:
a) for lectures: based on answers to questions about the material discussed in previous lectures,
b) for projects: based on the evaluation of the current progress of the project, the final evaluation of the project implementation and its description,
Summary evaluation:
a) in the scope of lectures, the verification of the assumed educational results is carried out by:
i. evaluation of the knowledge and skills shown at: #) theoretical and practical colloquium, or $) presentation of the project assumptions and results in front of the group audience,
ii. assessment of knowledge and skills based on: #) individual discussion of the results of the colloquium (additional control questions), or $) answers to questions concerning the assumptions and results of the presented project;
b) within the scope of the project the verification of the assumed educational results is carried out by:
i. continuous evaluation, during each class (oral answers), rewarding the increase of skills in using the learned principles and methods,
ii. an assessment of the knowledge and skills demonstrated in defense of the project that was carried out, which should include: #) formulating the control problem and defining the scope of its realization, $) presenting the method of solving the project problem, %) presenting the way of realization of the solution (simulation tests, practical tests), &) presenting the evaluation of the method, way of operation, test results.

Programme content

The lecture program includes the following issues:
1. Structures of automatic control systems: robust properties, input and interference sensitivity, standard structure, feedback structure -- feedback forward, with Smith's predictor, control via model, structure with internal IMC control model, structure with two degrees of freedom, two-loop control structure following the MFC model, structure with interference observer, properties of MFC structure.
2. Introduction to process automation systems: process control blocks, regulators, correction blocks, multidimensional systems in the input-output approach, control path interactions, input/output pairing, relationship coefficient matrix, uncoupling.
3. Cascade control: object-process model, interaction states, process block diagrams, properties of control elements, cascade interactions, cascade tuning, integration process.
4. Problem of saturation in control signals and its effects: limitations of the output of the controller, limitations of the process substitutes, limitations in the dependencies of variables.

5. Delayed process control: Smith's predictor and its variants.
6. Control diagrams of type: proportion control, control with range splitting, control with interference.
7. Basics of predictive control with limitations: layered structure of control, basics of optimization, regulation with shifting horizon, trajectories of regulated quantity and control, function of target and its properties, predicted output trajectory.
8. Predictive control using DMC technique, output prediction for SISO type systems, output prediction for MIMO type systems.
9. Industrial case study.
10. Examples of commercial solusion of APC and their discussion.
The project tasks are held in 2-person teams. Teams apply theoretical solutions in modeling control processes and program controllers checking the application of process automation algorithms in practice. Project topics include case studies supported by publications and literature, verified by means of simulation tools (e.g. Matlab), practical control solutions with their verification by means of programmable controllers (e.g. Simatic S7) or selected solutions applicable in industrial practice.
Examples of project topics:
1. Multi-sectional temperature control system of a two-stage extruder.
2. Control of the petrochemical distillation column model.
3. Control of a multi-pump hydrophore unit.
4. Use of split range control in air conditioning and heating devices.
5. Testing of variant predictive control to control the parameters of chemical reaction.

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Teaching methods

1. Lecture: multimedia presentation, solving sample project tasks
2. Project: definition of a project task, development of a solution and application in simulation or

experimental practice, discussion of results.

Bibliography

Basic
1. S. Skoczowski, R. Osypiuk, K. Pietrusewicz, Odporna regulacja PID o dwóch stopniach swobody, Wydawnictwo Naukowe PWN, Warszawa 2006.
2. P. Tatjewski, Sterowanie zaawansowane obiektów przemysłowych. Struktury i algorytmy, AOW EXIT, Warszawa 2002.
3. C. L. Smith, Advanced Process Control. Beyond Single-Loop Control, John Wiley & Sons, Inc., Hoboken, New Jersey, 2010.
Additional
1. W. H. Ray, Advanced Process Control, Butterworths Publishers, London 1989.

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	60	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	15	0,50