COURSE DESCRIPTION CARD - SYLLABUS

Course name
Advanced process automation [N2AiR1-SSiR>ZAP]

Course

Field of study
Automatic Control and Robotics

Year/Semester
1/1

Area of study (specialization)
Control and Robotic Systems

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
part-time

Requirements
compulsory

Number of hours

Lecture
20

Laboratory classes
10

Other
0

Tutorials
0

Projects/seminars
10

Number of credit points

4,00

Coordinators

dr inż. Jarosław Majchrzak
jaroslaw.majchrzak@put.poznan.pl

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; [K2_W7]
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; [K2_W12]
3. has knowledge of development trends and the most important new developments in the field of automation and related scientific disciplines; [K2_W12]
4. has knowledge of basic criteria of controller synthesis and tuning methods, tools and techniques for selecting controller settings and identifying control objects; [K2_W7]
5. has theoretical knowledge of process automation systems, possibilities of solving control problems in this area; [K2_W12]
Skills
1. is able to apply the chosen regulation technique and adjust it to the properties of the object and the system of regulation; [K2_U9], [K2_U23]
2. is able to select parameters and settings of a basic industrial controller and to configure and program an industrial programmable controller; [K2_U19], [K2_U25]
3. is able to design and practically use simple diagnostic and decision making systems dedicated to automation systems; [K2_U13], [K2_U25], [K2_U27]
4. is able to critically evaluate and select appropriate methods and tools to solve an automation task; [K2_U21], [K2_U23]
Social competences
1. understands that knowledge and skills in the module's subject matter must be supplemented; [K2_K4]
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; [K2_K4]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
The knowledge acquired during the lecture is verified by two 45-minute colloquia carried out during the 7th and 15th lectures. Each of the colloquiums consists of 10-15 questions (test and open questions), differently scored. The pass threshold is 50% of the points. The credit issues, on the basis of which the questions are prepared, are made available to students using the university's e-mail system or remote access WEB.
The skills acquired during the laboratory classes are verified on the basis of prepared reports and the final credit colloquium, consisting of 5-7 questions/tasks, differently scored depending on their level of difficulty and on the basis of developed project/model of regulation system. The credit threshold: 50% of points.

Programme content

The lecture program includes the following issues:
1. Structures of automatic control systems: immune properties, input and interference sensitivity, standard structure, feedback structure -- feedback forward, with Smith's predecessor, 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 predecessor 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 APC systems and their discussion.
The laboratory exercises are held in 2-person teams. Laboratory tasks are realized on stands equipped with a PC and simulation software. The program of laboratory exercises includes modelling and analysis of operation of selected process automation systems.
Sample topics of laboratory exercises:
1. Process control as a one-dimensional dynamic object (in the simulator).
2. Determination of operating parameters of control systems.
3. Analysis of selection of regulators' settings in control systems with static and astatic objects.
4. Control of the real process as a one-dimensional dynamic object.
5. Modelling of a chemical object based on state equations. Determination of its dynamic properties.
6. Examination of the operation of regulators in the model of cascade regulation system.
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.

Course topics

none

Teaching methods

1. Lecture: multimedia presentation, solving sample project tasks
2. Laboratory exercises: multimedia presentation illustrated with examples given on the board and the performance of tasks given by the instructor - practical exercises
3. 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	100	4,00
Classes requiring direct contact with the teacher	40	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	60	1,50