GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Automation and sensor systems, PG_00057799		
Field of study	Green Technologies		
Date of commencement of studies	October 2024	Academic year of realisation of subject	2026/2027
Education level	first-cycle studies	Subject group	Optional subject group Subject group related to scientific research in the field of study
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	3	Language of instruction	English
Semester of study	5	ECTS credits	6.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Process Engineering and Chemical Technology -> Faculty of Chemistry -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Bartosz Szulczyński	
	Teachers	dr inż. Bartosz Szulczyński mgr inż. Dominik Dobrzyniewski	

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	15.0	30.0	0.0	0.0	75

E-learning hours included: 0.0

eNauczanie source addresses:

Moodle ID: 9203 Automation and sensor systems 2026/2027
https://enauczanie.pg.edu.pl/2025/course/view.php?id=9203

Learning activity and number of study hours

Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM
Number of study hours	75	15.0	60.0	150

Subject objectives

The aim of the course is to familiarise students with the operating principles, construction, metrological characteristics, and applications of sensors and measuring instruments used to monitor technological process parameters, such as temperature, pressure, flow rate, level, and the physicochemical properties of process media. The course covers the selection and evaluation of measurement systems, signal processing and interpretation, and the fundamentals of process automation, including the structure of control systems, the operation of final control elements, process dynamics modelling, controller tuning, and the analysis of control system stability and performance. Students acquire the knowledge and skills necessary to select measuring instruments and automation components and to analyse control system performance in process engineering and chemical technology.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_W03] has a basic knowledge of soil, air and water pollutants, design and supervision of environmentally friendly technologies and technologies which do not produce waste, knows technology of cleaning and neutralization of industrial waste and wastewater management, has a basic understanding of the theoretical basis of methods and types of apparatus used in chemical analysis of environmental pollutants	knows the basic operating principles and applications of sensors, measuring instruments, and automatic control systems used to monitor environmental parameters and supervise technological processes, particularly in air, water, and soil protection, wastewater treatment, and pollution emission reduction.	[SW1] Assessment of factual knowledge
[K6_K04] is ready to think and act in a creative and enterprising way, to negotiate, work in a team, assuming different roles	is prepared to adopt a creative and entrepreneurial approach to solving problems related to measurement and process automation, as well as to collaborate in a team when carrying out design and laboratory tasks, participate in technical discussions, and assume different roles within the team.	[SK1] Assessment of group work skills [SK5] Assessment of ability to solve problems that arise in practice
[K6_U05] can formulate and solve engineering tasks analytical methods, simulation as well as experimental, able to apply knowledge of basic physics and mathematics to analyze the results of experiments, is able to analyze and assess existing technical solutions	is able to use analytical, simulation, and experimental methods to solve engineering problems related to measurement and process automation, apply basic knowledge of physics and mathematics to analyse measurement and experimental results, and evaluate the performance and suitability of existing technical solutions involving sensors, measuring instruments, and control systems.	[SU3] Assessment of ability to use knowledge gained from the subject [SU1] Assessment of task fulfilment
[K6_W06] has a basic knowledge of chemical engineering, mechanical engineering and chemical equipment, knows and understands basic processes taking place in green, proenvironmental technologies	has knowledge of the operating principles and applications of sensors, measuring instruments, and control systems used to monitor and control chemical engineering processes, including those employed in green and environmentally friendly technologies.	[SW1] Assessment of factual knowledge
[K6_U03] is able to use information and communication technologies relevant to the common tasks of engineering, is able to use known methods and mathematical-physical models to describe and explain phenomena and chemical processes	is able to use information technology tools and mathematical and physical methods and models to analyse measurement signals, interpret measurement results, and describe and analyse the operation of sensors and automatic control systems used in chemical engineering processes.	[SU2] Assessment of ability to analyse information [SU4] Assessment of ability to use methods and tools

Subject contents

Course content – lecture

The lectures cover issues related to the measurement of physicochemical quantities and process automation in the chemical industry. The course begins with an introduction to basic concepts in metrology and automation, as well as the role of measurements and control in ensuring the quality and safety of technological processes. Students become familiar with the classification of sensors, the principles of measuring key process variables, and the structure of typical measurement and control systems. Metrological parameters of sensors, their static and dynamic characteristics, as well as methods of calibration and verification of measurement instruments are presented.
Subsequent lectures address methods and devices used for measuring temperature, pressure, flow, conductivity, pH, and electrochemical potential, with particular emphasis on their design, operating principles, accuracy, and application conditions. Issues related to gas chemical sensors and their role in monitoring technological processes are also discussed.
The next part of the course focuses on the fundamentals of process automation. It includes the structure of an automatic control system, types of signals and controlled objects, and the rules for constructing and simplifying block diagrams. Students learn methods of mathematical modelling of dynamic systems, analysis of their responses to external inputs, and interpretation of control error and its impact on system accuracy.
Further topics include the stability of control systems, with an introduction to key criteria (e.g., Hurwitz) and the importance of component parameters in shaping the systems dynamic characteristics. The course also covers automatic controllers (P, PI, PID), their operating principles, characteristics, tuning methods, and their effect on control performance. Special attention is given to empirical tuning methods, such as the ZieglerNichols method.

Course content – exercises

The exercises cover problem-solving related to physicochemical measurements and the fundamentals of automation and process control. The first part focuses on temperature calculations using thermocouples, Pt100 sensors and thermistors, pressure determination based on the hydrostatic equation, and flow rate calculations. Students also solve problems involving solution pH and electrolytic conductivity, and interpret sensor characteristics, including sensitivity, linear operating range, limits of detection and limits of quantification. The second part covers the analysis of automation system structures, determination of time constants and dynamic characteristics of process elements, block diagram reduction, and feedback analysis. Students calculate control errors, assess system stability using the Hurwitz criterion, analyse system responses to input signals and disturbances, and determine the parameters of P, PI and PID controllers, including tuning by the Ziegler–Nichols method. The tutorials also address control performance assessment and comparison of different control system configurations.

Course content – laboratory

The laboratory classes involve practical measurements and the analysis of the static and dynamic properties of sensors and components used in process automation systems. During the laboratory sessions, students become familiar with methods of measuring and controlling humidity in gases, as well as with the operating principle of gas chemical sensors, illustrated by the example of an NDIR sensor for carbon dioxide concentration measurement. The static characteristics of resistive metal thermometers and the dynamic characteristics of temperature sensors under various measurement conditions are examined and discussed.
Students analyse the influence of convection conditions on the dynamic behaviour of temperature sensors and investigate heat transfer dynamics in systems with different inertia parameters. Another component of the laboratory work involves determining the characteristics of systems composed of series-connected first-order inertial elements and analysing the responses of such systems to external excitations.
In the final part of the course, students conduct experiments related to the operation of automatic controllers, determining their influence on the stability and quality of process control.

Prerequisites and co-requisites

Basic knowledge of mathematics, physics, and chemical engineering, particularly of fundamental physical phenomena and technological processes.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Lecture Tests	60.0%	30.0%
Lab test	60.0%	40.0%
Ecercise Tests	60.0%	30.0%

Recommended reading

Basic literature	1. Dunn William: Fundamentals of Industrial Instrumentation and Process Control, 2. Gregory K. Mcmillan, P. Hunter Vegas: Process / Industrial Instruments and Controls Handbook 3. Dale R. Patrick;Stephen W. Fardo: Industrial Process Control Systems 4. Katariya Sanjay B: Industrial Automation Solutions for Plc, Scada, Drive and Field Instruments: Easy to Learn Industrial Automation
Supplementary literature	There are no requirements

	eResources addresses	
Example issues/ example questions/ tasks being completed	1. The first-order inertial object transfer function has the form 2. Describe the Hurwitz stability criterion 3. Determine the Laplace transform of the given function 4. Determine the dependence of the signal on the measured quantity for resistive temperature sensors	
Practical activites within the subject	Not applicable	

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