# GDAŃSK UNIVERSITY OF TECHNOLOGY

## Subject card

| Subject name and code | Control and Decision Support Systems, PG_00057478 | | | | | |
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| Field of study | Automation, Robotics and Control Systems | | | | | |
| Date of commencement of studies | February 2025 | | Academic year of realisation of subject | | 2024/2025 | |
| Education level | second-cycle studies | | Subject group | | | |
| Mode of study | Full-time studies | | Mode of delivery | | at the university | |
| Year of study | 1 | | Language of instruction | | Polish | |
| Semester of study | 1 | | ECTS credits | | 2.0 | |
| Learning profile | general academic profile | | Assessment form | | assessment | |
| Conducting unit | Department of Intelligent and Decision Support Systems -> Faculty of Electrical and Control Engineering | | | | | |
| Name and surname of lecturer (lecturers) | Subject supervisor | | dr inż. Tomasz Rutkowski | | | |
| | Teachers | | dr inż. Tomasz Rutkowski | | | |

| Lesson types and methods of instruction | Lesson type | Lecture | Tutorial | Laboratory | Project | Seminar | SUM |
|---|---|---|---|---|---|---|---|
| | Number of study hours | 15.0 | 0.0 | 0.0 | 15.0 | 0.0 | 30 |
| | E-learning hours included: 0.0 | | | | | | |

| 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 | 30 | 4.0 | 16.0 | 50 |

| Subject objectives | The aim of the course is for the student to master knowledge in the area of selected advanced control structures and algorithms for objects pursuing complex control objectives. In addition, the student will learn selected issues from the area of decision support systems and advanced optimisation methods as synthesis tools. |
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| Learning outcomes | Course outcome | Subject outcome | Method of verification |
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| | [K7_W02] has a structured knowledge of the application of information systems to improve the reliability, efficiency, speed and mobility of control and management systems | Defines the characteristics of selected advanced control structures and algorithms. Selects advanced control methods for objects/processes based on their characteristics. Defines selected elements of advanced decision support methods. | [SW1] Assessment of factual knowledge [SW3] Assessment of knowledge contained in written work and projects |
| | [K7_U11] is able to design and realise simple electrical circuits and control systems for a facility or industrial process using computer systems | Uses learned advanced control structures in projects. Implements selected advanced control algorithms. Implements simple decision support systems. Evaluates the quality of operation of applied control systems. | [SU1] Assessment of task fulfilment [SU3] Assessment of ability to use knowledge gained from the subject [SU5] Assessment of ability to present the results of task |

| Subject contents | LECTURES: Aspects of modelling dynamics systems: linear and nonlinear with distributed and concentrated dynamics, continuous and discrete, mixed and event dynamics. Uncertainty modelling methods: stochastic, interval deterministic and mixed. Control and decision support structures: centralized and decentralized, with information exchange, with negotiation and consensus mechanisms, hierarchical with coordination. Trajectory tracking control in the cascade control structure. Problems of direct adaptive control based on the DMRAC model (Direct Model Reference Adaptive Control). Decision support systems as control systems. Problems of multi-criteria linear programming, Pareto optimality. Introduction to optimizing MPC (Model Predictive Control) control, aspects of taking into account changes in process operating conditions (soft switching), robustness's mechanisms. The classical genetic algorithm as a method for solving optimization problems.<br><br>PROJECT: The project classes are based on the Matlab/Simulink software with prepared utility tools (scripts, models), and its scope includes the content presented during lectures such as:<br>- synthesis of a trajectory tracking cascade control system for the vertical inclination of the radar bowl, taking into account the presence of friction forces and measurement noise (LuGre friction model, PI regulator with adapted parameters: fuzzy logic, Mamdani inference),<br>- synthesis of the oxygen concentration control system in a biological reactor using Direct Model Reference Adaptive Control (DMRAC),<br>- synthesis of predictive control with a linear object model in a multivariate, nonlinear chemical reactor with a continuous flow of components (CSTR),<br>- the classic Genetic Algorithm (GA) as a tool for solving optimization problems,<br>- decision support problem based on the example of Portfolio optimization of the investment portfolio of an individual investor. |
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| Prerequisites and co-requisites | |

| Assessment methods and criteria | Subject passing criteria | Passing threshold | Percentage of the final grade |
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| | Lecture Test | 50.0% | 50.0% |
| | Projects Reports | 50.0% | 50.0% |

| Recommended reading | Basic literature | 1) Slotine Jean Jacques E., W. Li: Applied Nonlinear Control. Prentice Hall, Englewood Cliffs, New Jersey 07632, 1991.<br>2) Brdys Mietek A., P. Tatjewski: Iterative Algorithms for Multilayer Optimizing Control, Imperial College Press, World Scientific Publishing Co. Pte. Ltd., 2005.<br>3) Rawlings J.B., D.Q. Mayne: Model Predictive Control: Theory and Design. Nob-Hill Publishing, 1st edition, 2009.<br>4) A.P. Wierzbicki, M. Makowski, J. Wessels: Model-Based Decision Support Methodology with Environmental Applications, Series: Mathematical Modeling and Applications. Kluwer Academic, Dordrecht, 2000.<br>5) J. Branke, K. Deb, K. Miettinen, R. Slowinski: Multiobjective Optimization: Interactive and Evolutionary Approaches, 2008. |
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| | Supplementary literature | 1) Hassan K. Khail: Nonlinear Systems. Prentice Hall, Englewood Cliffs, New Jersey 07632, 2002.<br>2) J. M. Maciejowski: Multivariable Feedback Design. Addison Wesley, 1989<br>3) Byrski W.: Obserwacja i Sterowanie w Systemach Dynamicznych. Uczelniane Wydawnictwa Naukowo Dydaktyczne Akademii Górniczo Hutniczej w Krakowie, 2007<br>4) Tatjewski P.: Sterowanie Zaawansowane Obiektów Przemysłowych struktury i algorytmy. Warszawa, Akad. Oficyna Wyd. EXIT, 2002. |
| | eResources addresses | Adresy na platformie eNauczanie: |

| Example issues/ example questions/ tasks being completed | - Synthesis of a trajectory tracking cascade control system for the vertical inclination of the radar bowl, taking into account the presence of friction forces and measurement noise (LuGre friction model, PI regulator with adapted parameters: fuzzy logic, Mamdani inference)<br>- Synthesis of the oxygen concentration control system in a biological reactor using Direct Model Reference Adaptive Control (DMRAC)<br>- Synthesis of predictive control with a linear object model in a multivariate, nonlinear chemical reactor with a continuous flow of components (CSTR)<br>- Classic Genetic Algorithm (GA) as a tool for solving optimization problems<br>- Decision support problem based on the example of Portfolio optimization of the investment portfolio of an individual investor |
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| Work placement | Not applicable |

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