



## Subject card

|   |   |  |  |                                     |  |            |     |
|---|---|--|--|-------------------------------------|--|------------|-----|
| Subject name and code                       | Basics of Discrete Systems, PG_00047618   |  |  |                                     |  |            |     |
| Field of study                              | Automatic Control, Cybernetics and Robotics   |  |  |                                     |  |            |     |
| Date of commencement of studies             | October 2022  |  | Academic year of realisation of subject                    |                                     | 2024/2025  |            |     |
| Education level                             | first-cycle studies   |  | Subject group  |                                     | Optional subject group<br>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                                    |                                     | Polish   |            |     |
| Semester of study                           | 6   |  | ECTS credits   |                                     | 4.0  |            |     |
| Learning profile                            | general academic profile  |  | Assessment form  |                                     | exam   |            |     |
| Conducting unit                             | Department of Decision Systems and Robotics -> Faculty of Electronics, Telecommunications and Informatics |  |  |                                     |  |            |     |
| Name and surname of lecturer (lecturers)    | Subject supervisor  |  | dr inż. Mariusz Domżałski                                  |                                     |  |            |     |
|   | Teachers  |  | dr inż. Sebastian Dziedziewicz<br><br>dr inż. Marek Tatara |                                     |  |            |     |
| Lesson types and methods of instruction     | Lesson type   | Lecture  | Tutorial   | Laboratory                          | Project  | Seminar    | SUM |
|   | Number of study hours   | 30.0   | 15.0   | 0.0                                 | 0.0  | 0.0        | 45  |
|   | 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   | 45   |  | 4.0                                 |  | 51.0       | 100 |
| Subject objectives                          | Mastering knowledge and acquiring skills in the field of process control in discrete-time.                |  |  |                                     |  |            |     |

| Learning outcomes | Course outcome   | Subject outcome  | Method of verification   |
|-------------------|--|--|--|
|                   | [K6_W04] knows and understands, to an advanced extent, the principles, methods and techniques of programming and the principles of computer software development or programming devices or controllers using microprocessors or programmable elements or systems specific to the field of study, and organisation of systems using computers or such devices   | Student knows the description of control systems and their contemporary ideas.   | [SW1] Assessment of factual knowledge  |
|                   | [K6_W01] knows and understands, to an advanced extent, mathematics necessary to formulate and solve simple issues related to the field of study  | Student knows the stability testing methods and synthesis of control systems (linear and nonlinear).                                       | [SW1] Assessment of factual knowledge  |
|                   | [K6_W03] knows and understands, to an advanced extent, the construction and operating principles of components and systems related to the field of study, including theories, methods and complex relationships between them and selected specific issues - appropriate for the curriculum   | Student has the knowledge of the basic problems of industrial computer control systems.  | [SW1] Assessment of factual knowledge  |
|                   | [K6_U01] can apply mathematical knowledge to formulate and solve complex and non-typical problems related to the field of study and perform tasks, in an innovative way, in not entirely predictable conditions, by:n- appropriate selection of sources and information obtained from them, assessment, critical analysis and synthesis of this information,n- selection and application of appropriate methods and toolsn | Student is able to analyze control systems with discrete time. Student is able to solve the problems of controlling discrete-time objects. | [SU3] Assessment of ability to use knowledge gained from the subject<br>[SU2] Assessment of ability to analyse information |

## Subject contents

### 1) Basics of processing and discrete control:

- General characteristics of discrete signals and systems;
- Methods for the analysis of discrete systems;
- Description methods of discrete and digital systems;

### 2) Discrete systems:

- Basic properties of discrete systems;
- Description of discrete systems using difference equations;
- Other ways of describing the discrete systems.

### 3) Z transformation:

- Introduction: deterministic signals;
- bilateral transformation;
- One-sided transformation;
- Multidimensional Transformation;
- Modified Z transformation;
- The inverse Z transform;
- Applications: transfer function based on differential equations, state equations, and graphs.

### 4) Stability of discrete systems:

- Necessary conditions and criteria for stability;
- Method of the 'w' plane;
- Frequency methods;
- Nyquist criterion;
- Marden-Yury criteria.

### 5) Spectral analysis of signals:

- Simple and inverse transformations;
- Sampling theorem;

|  |  |  |                               |
|--|--|--|-------------------------------|
|  | <ul style="list-style-type: none"><li>- Discrete Fourier Transform.</li></ul> <p>6) The theory of discrete linear systems:</p> <ul style="list-style-type: none"><li>- Reachability and controllability;</li><li>- Reproducibility and observability;</li><li>- The theory of discrete linear systems;</li><li>- Stabilizability and the complete description of systems;</li><li>- Identity transformations.</li><li>- The canonical structure of discrete linear systems;</li><li>- Diagonal form, Vandermonde matrix;</li><li>- Determining the transformation matrix;</li><li>- Canonical structure of discrete linear systems;</li><li>- Determining the transformation matrix; Normal forms and their transformation matrices for the regulator, observer, controllable, and observable forms.</li></ul> |  |                               |
| Prerequisites and co-requisites                                |  |  |                               |
| Assessment methods and criteria                                | Subject passing criteria   | Passing threshold  | Percentage of the final grade |
|  | exercise   | 50.0%  | 40.0%                         |
|  | exam   | 50.0%  | 60.0%                         |
| Recommended reading  | Basic literature   | A.V. Oppenheim, R.W. Schafer: "Discrete-time Signal Processing" Prentice Hall 1975   |                               |
|  | Supplementary literature   | Norman S. Nise, "Control Systems Engineering", Willey, 2010<br><br>Monson Hayes, "Schaums Outline of Digital Signal Processing", McGraw-Hill, 2011 |                               |
|  | eResources addresses   | Adresy na platformie eNauczanie:   |                               |
|  |  |  |                               |
| Example issues/<br>example questions/<br>tasks being completed | <ul style="list-style-type: none"><li>1) Determine the step response for a system described by a given transmittance <math>G(z)</math>.</li><li>2) Draw the graph and determine the transmittance of a system described by a state model A, B, C, D.</li><li>3) Determine the frequency characteristics of a system described by a given transmittance <math>G(z)</math>.</li><li>4) Examine the stability of the system.</li><li>5) Examine whether the system is controllable / observable.</li></ul>  |  |                               |
| Work placement   | Not applicable   |  |                               |

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