



## Subject card

|                                             |                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                          |                                                                                                                                                                                                                                                     |                                     |         |                                                                                                                      |     |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|---------|----------------------------------------------------------------------------------------------------------------------|-----|
| Subject name and code                       | Statistics and Statistical Testing in Engineering Perspective, PG_00068081                                                                                                                                                                                                                                                                                                                                                 |                                                          |                                                                                                                                                                                                                                                     |                                     |         |                                                                                                                      |     |
| Field of study                              | Automatic Control, Cybernetics and Robotics                                                                                                                                                                                                                                                                                                                                                                                |                                                          |                                                                                                                                                                                                                                                     |                                     |         |                                                                                                                      |     |
| Date of commencement of studies             | October 2025                                                                                                                                                                                                                                                                                                                                                                                                               |                                                          | Academic year of realisation of subject                                                                                                                                                                                                             |                                     |         | 2027/2028                                                                                                            |     |
| Education level                             | first-cycle studies                                                                                                                                                                                                                                                                                                                                                                                                        |                                                          | Subject group                                                                                                                                                                                                                                       |                                     |         | Obligatory subject group in the field of study<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                                                                                                                                                                                                                                        |                                     |         | 2.0                                                                                                                  |     |
| Learning profile                            | general academic profile                                                                                                                                                                                                                                                                                                                                                                                                   |                                                          | Assessment form                                                                                                                                                                                                                                     |                                     |         | assessment                                                                                                           |     |
| Conducting unit                             | Mathematics Center -> Vice-Rector For Education                                                                                                                                                                                                                                                                                                                                                                            |                                                          |                                                                                                                                                                                                                                                     |                                     |         |                                                                                                                      |     |
| Name and surname of lecturer (lecturers)    | Subject supervisor                                                                                                                                                                                                                                                                                                                                                                                                         |                                                          | dr Lech Kujawski                                                                                                                                                                                                                                    |                                     |         |                                                                                                                      |     |
|                                             | Teachers                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                          | dr Lech Kujawski                                                                                                                                                                                                                                    |                                     |         |                                                                                                                      |     |
| Lesson types                                | Lesson type                                                                                                                                                                                                                                                                                                                                                                                                                | Lecture                                                  | Tutorial                                                                                                                                                                                                                                            | Laboratory                          | Project | Seminar                                                                                                              | SUM |
|                                             | Number of study hours                                                                                                                                                                                                                                                                                                                                                                                                      | 15.0                                                     | 0.0                                                                                                                                                                                                                                                 | 15.0                                | 0.0     | 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                                                       |                                                                                                                                                                                                                                                     | 2.0                                 |         | 18.0                                                                                                                 | 50  |
| Subject objectives                          | Familiarize students with the fundamental concepts of probability theory and statistics.<br>Develop students skills in analyzing and interpreting numerical data, as well as assessing its quality.<br>Acquire competencies in applying statistical methods for data-driven decision-making based on sample information.<br>Prepare students to utilize Six Sigma tools in diagnosing and optimizing production processes. |                                                          |                                                                                                                                                                                                                                                     |                                     |         |                                                                                                                      |     |
| Learning outcomes                           | Course outcome                                                                                                                                                                                                                                                                                                                                                                                                             |                                                          | Subject outcome                                                                                                                                                                                                                                     |                                     |         | Method of verification                                                                                               |     |
|                                             | [K6_U07] can apply methods of process and function support, specific to the field of study                                                                                                                                                                                                                                                                                                                                 |                                                          | The student is familiar with statistical methods applicable to the analysis of data relevant to their field of study.                                                                                                                               |                                     |         | [SU4] Assessment of ability to use methods and tools                                                                 |     |
|                                             | [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 |                                                          | The student is capable of independently conducting a statistical study aimed at testing parametric or nonparametric hypotheses in populations or a univariate population.                                                                           |                                     |         | [SU4] Assessment of ability to use methods and tools                                                                 |     |
|                                             | [K6_W01] knows and understands, to an advanced extent, mathematics necessary to formulate and solve simple issues related to the field of study                                                                                                                                                                                                                                                                            |                                                          | The student understands the need to deepen their knowledge and acquire skills in the applications of statistics. They are capable of supplementing and refining their acquired knowledge and skills, and can work systematically and independently. |                                     |         | [SW3] Assessment of knowledge contained in written work and projects                                                 |     |

**1. Probability Theory**

- Random experiments and random events
- Random variables and types of random variables
- Distribution parameters of a random variable
- Classical and positional measures of central tendency, dispersion, skewness, and concentration

**2. Overview of Fundamental Probability Distributions**

- Bernoulli (01) distribution
- Binomial distribution
- Poisson distribution
- Normal distribution
- Students  $t$  distribution
- Chi-squared distribution
- FisherSnedecor (F) distribution
- Weibull distribution

**3. Sampling and Sample Distributions**

- Sampling procedures
- Statistics as estimators of population parameters
- Properties of estimators
- Degrees of freedom

**4. Graphical Presentation of Statistical Data**

- Histogram
- Box plot
- Frequency polygon
- Area chart

- Stacked area chart

## **5. Statistical Hypothesis Testing Parametric Methods**

- Principles of hypothesis verification
- Parametric hypothesis tests for one or two populations
- Tests of means (including ANOVA and MANOVA)
- Tests of variance
- Tests of proportions

## **6. Statistical Hypothesis Testing Nonparametric Methods**

- Nonparametric tests for univariate population characteristics
- Nonparametric tests for comparing two populations
- Tests of randomness
- Goodness-of-fit tests
- Nonparametric ANOVA, including:
  - MannWhitney U test
  - KruskalWallis test

## **7. Analysis of Dependence**

- Correlation measures for quantitative variables
- Pearson correlation coefficient
- Spearman rank correlation coefficient
- Linear and nonlinear regression models

## **8. Six Sigma Methodology**

- Principles and structure of Six Sigma
- Application of statistical methods in optimizing production processes

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Course content – laboratory

## **1. Probability Theory**

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## **5. Statistical Hypothesis Testing Parametric Methods**

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|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|-------------------------------|
|                                 | <ul style="list-style-type: none"> <li>Principles of hypothesis verification</li> <li>Parametric hypothesis tests for one or two populations</li> <li>Tests of means (including ANOVA and MANOVA)</li> <li>Tests of variance</li> <li>Tests of proportions</li> </ul> <p><b>6. Statistical Hypothesis Testing Nonparametric Methods</b></p> <ul style="list-style-type: none"> <li>Nonparametric tests for univariate population characteristics</li> <li>Nonparametric tests for comparing two populations</li> <li>Tests of randomness</li> <li>Goodness-of-fit tests</li> <li>Nonparametric ANOVA, including: <ul style="list-style-type: none"> <li>MannWhitney U test</li> <li>KruskalWallis test</li> </ul> </li> </ul> <p><b>7. Analysis of Dependence</b></p> <ul style="list-style-type: none"> <li>Correlation measures for quantitative variables</li> <li>Pearson correlation coefficient</li> <li>Spearman rank correlation coefficient</li> <li>Linear and nonlinear regression models</li> </ul> <p><b>8. Six Sigma Methodology</b></p> <ul style="list-style-type: none"> <li>Principles and structure of Six Sigma</li> <li>Application of statistical methods in optimizing production processes</li> </ul> |                                                                                            |                               |
| Prerequisites and co-requisites |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                            |                               |
| Assessment methods and criteria | Subject passing criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Passing threshold                                                                          | Percentage of the final grade |
|                                 | Autonomous preparation of a semester research paper.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 51.0%                                                                                      | 100.0%                        |
| Recommended reading             | Basic literature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | L.M. Chihara, T.C. Hesterberg, Mathematical Statistics with Resampling and R, Wiley, 2022. |                               |
|                                 | Supplementary literature                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Hogg, McKean, Craig ,Introduction to Mathematical Statistics, 2022.                        |                               |
|                                 | eResources addresses                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                            |                               |

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|----------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| Example issues/<br>example questions/<br>tasks being completed | Autonomous execution of statistical research and drawing of conclusions on an assigned topic. |
| Practical activities within<br>the subject                     | Not applicable                                                                                |

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