



Subject card

Subject name and code	Mathematical Statistics, PG_00021039						
Field of study	Mathematics						
Date of commencement of studies	October 2026	Academic year of realisation of subject			2026/2027		
Education level	second-cycle studies	Subject group			Specialty 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	1	Language of instruction			Polish		
Semester of study	1	ECTS credits			4.0		
Learning profile	general academic profile	Assessment form			assessment		
Conducting unit	Institute of Applied Mathematics -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor	dr Maryna Shcholokova					
	Teachers	dr Maryna Shcholokova					
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	30.0	0.0	0.0	0.0	60
	E-learning hours included: 0.0						
	eNauczenie source address: https://enauczenie.pg.edu.pl/2025/course/view.php?id=1190						
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	60	5.0		35.0		100
Subject objectives	The aim of the course "Mathematical Statistics" is to teach students how to analyze and interpret statistical data using methods of descriptive and mathematical statistics. This course aims to equip students with a specialized mathematical toolkit that supports technical subjects related to mathematical modeling, data analysis, and applications of statistics.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_U03] uses differential and integral calculus, elements of complex analysis, algebraic methods, applies them in typical practical	The student is able to apply differential and integral calculus, elements of complex analysis, and algebraic methods to solve statistical problems.	[SU3] Assessment of ability to use knowledge gained from the subject [SU1] Assessment of task fulfilment
	[K7_U06] uses probability distributions and their properties in practical issues, is familiar with the basics of statistics and the basics of statistical data processing	The student is able to apply probability distributions and statistical methods to data analysis in practical contexts, independently perform parameter estimation, hypothesis testing, and interpret results. The student understands the importance of accurate statistical analysis, can collaborate within a project team, and effectively present research findings.	[SU3] Assessment of ability to use knowledge gained from the subject [SU2] Assessment of ability to analyse information
	[K7_W02] has enhanced knowledge of a selected branch of mathematics, theoretical or applied, knows classical definitions and theorems and their proofs and connections with other fields, understands problems being examined	The student possesses advanced knowledge of mathematical statistics, including classical definitions and theorems (e.g., Rao-Cramer theorem, central limit theorem) and their applications in data analysis. They understand the connections between statistics, other branches of mathematics, and empirical sciences. The student is able to explain the theoretical foundations of applied statistical methods, identify their limitations, and interpret results in both practical and research contexts.	[SW2] Assessment of knowledge contained in presentation [SW3] Assessment of knowledge contained in written work and projects [SW1] Assessment of factual knowledge

Subject contents	<p>Course content – lecture</p> <p>1. Fundamentals of statistical space and random sampling Definitions, types of samples, simple random sampling, sampling schemes discussed during lectures and exercises.</p> <p>2. Empirical distribution and fundamental statistical theorems Law of large numbers, central limit theorem, interpretation of empirical distribution lectures and exercises.</p> <p>3. Positional statistics and sample quantiles Median, quartiles, deciles, and their application in data analysis computational exercises.</p> <p>4. Estimation of population parameters Estimators, estimation methods (method of moments, maximum likelihood), Rao-Cramer theorem, properties of estimators lectures and exercises.</p> <p>5. Point and interval estimation Construction of confidence intervals, interpretation of confidence level exercises.</p> <p>6. Hypothesis testing Simple and composite hypotheses, Type I and II errors, test power lectures and exercises.</p> <p>7. Statistical tests Parametric tests (e.g., t-test, F-test) and nonparametric tests (e.g., Mann-Whitney U test, chi-square test) lectures and exercises.</p> <p>8. Regression analysis Linear and nonlinear regression, coefficient estimation, model interpretation lectures and exercises.</p> <p>9. Statistical project Design and analysis of real-world data, method selection, result interpretation conducted as a group project and presented during seminars.</p> <p>Statistical Methods and Tests Applied in Student Projects</p> <ul style="list-style-type: none"> • Logistic regression binary outcome analysis (topics: 1, 5, 13); Wald test, Hosmer-Lemeshow goodness-of-fit • Linear regression relationship between quantitative variables (topics: 4, 10); F-test, t-test for coefficients • Chi-square test for independence (topics: 3, 5) and goodness-of-fit (topic: 11) • McNemar test comparison of paired binary outcomes before and after intervention (topic: 6) • Independent samples t-test comparison of means between groups (topic: 12) • Dependent samples t-test change over time within the same group (topic: 7) • Mann-Whitney U test comparison of ordinal distributions (topics: 5, 9) • Pearson correlation strength of association between quantitative variables (topic: 8) • ANOVA comparison of means across multiple groups (topic: 2); Levenes test, Tukeys post-hoc test <p>Project Topics and Educational Objectives</p> <p>1. Lifestyle and spinal health knowledge Educational goal: Learn logistic regression and coefficient interpretation Data: Lifestyle indicators (sleep, activity, ergonomics quantitative and binary), knowledge (correct/incorrect binary) Sample size: 100 Tests: Logistic regression, Wald test Hypotheses: H: Lifestyle does not affect knowledge H: Lifestyle affects knowledge</p>
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- 2. Education level and spinal health knowledge** Educational goal: Learn ANOVA and post-hoc testing
Data: Education level (nominal), number of correct answers (quantitative) Sample size: 90 Tests: ANOVA, Levenes test, Tukeys test Hypotheses: H: Mean knowledge does not differ between groups H: Mean knowledge differs between groups
- 3. Back pain and preventive awareness** Educational goal: Learn chi-square test and contingency table analysis
Data: Back pain (binary), knowledge (binary) Sample size: 80 Tests: Chi-square, Cramér V Hypotheses: H: Back pain is independent of knowledge H: Back pain is associated with knowledge
- 4. Lifestyle and stress level** Educational goal: Learn multiple regression and residual analysis
Data: Sleep, screen time, diet, activity (quantitative), stress (scale 110) Sample size: 100 Tests: Linear regression, F-test Hypotheses: H: Lifestyle does not affect stress H: Lifestyle affects stress
- 5. Daily habits and back pain** Educational goal: Learn logistic regression and nonparametric testing
Data: Sitting time (quantitative), bag type (nominal), warm-up (binary), pain (binary), well-being (ordinal) Sample size: 100 Tests: Chi-square, logistic regression, Mann-Whitney U test Hypotheses: H: Habits do not affect pain H: Habits affect pain
- 6. Educational campaign and knowledge improvement** Educational goal: Learn McNemar test for paired binary data
Data: Knowledge before and after campaign (binary) Sample size: 60 Tests: McNemar Hypotheses: H: Campaign does not change knowledge H: Campaign increases knowledge
- 7. Stress before and after exam session** Educational goal: Learn dependent samples t-test
Data: Stress before and after session (scale 110) Sample size: 40 Tests: Dependent t-test Hypotheses: H: Mean stress does not change H: Mean stress changes after session
- 8. Screen time and sleep quality** Educational goal: Learn Pearson correlation and data visualization
Data: Screen time (quantitative), sleep quality (ordinal treated as quantitative) Sample size: 50 Tests: Pearson correlation Hypotheses: H: No relationship between screen time and sleep H: Relationship exists between screen time and sleep
- 9. Physical activity and well-being** Educational goal: Learn nonparametric testing
Data: Activity (binary), well-being (ordinal) Sample size: 60 Tests: Mann-Whitney U test Hypotheses: H: Activity does not affect well-being H: Activity affects well-being
- 10. Age and spinal health knowledge** Educational goal: Learn linear regression and coefficient interpretation
Data: Age (quantitative), number of correct answers (quantitative) Sample size: 50 Tests: Linear regression Hypotheses: H: Age does not affect knowledge H: Age affects knowledge
- 11. Do respondents guess in the True/False quiz?** Educational goal: Learn goodness-of-fit testing and distribution analysis
Data: Distribution of answers (binary) Sample size: 100 Tests: Chi-square goodness-of-fit Hypotheses: H: Answer distribution is random H: Answer distribution differs from random
- 12. Physiotherapy consultation and knowledge** Educational goal: Learn independent samples t-test
Data: Consultation (binary), test score (quantitative) Sample size: 60 Tests: Independent t-test, Levenes test Hypotheses: H: Consultation does not affect knowledge H: Consultation affects knowledge
- 13. Knowledge and willingness to change lifestyle** Educational goal: Learn logistic regression and probability interpretation
Data: Knowledge (quantitative), lifestyle change declaration (binary) Sample size: 100 Tests: Logistic regression, Wald test Hypotheses: H: Knowledge does not affect willingness to change H: Knowledge affects willingness to change

Prerequisites and co-requisites	<p>Before starting the course Mathematical Statistics, a student should possess the following knowledge, skills, and competencies:</p> <ol style="list-style-type: none"> 1. Basic knowledge of probability calculus understanding concepts such as random variables, probability distributions, expected value, and variance. 2. Ability to use differential and integral calculus familiarity with basic differential and integral operations and their applications. 3. Fundamentals of linear algebra understanding concepts such as matrices, vectors, determinants, and systems of linear equations. 4. Knowledge of basic descriptive statistics concepts ability to calculate and interpret measures of central tendency (mean, median, mode) and measures of dispersion (standard deviation, variance). 5. Basic programming skills familiarity with basic tools used in data analysis. 											
Assessment methods and criteria	<table border="1"> <thead> <tr> <th data-bbox="453 837 790 869">Subject passing criteria</th> <th data-bbox="799 837 1141 869">Passing threshold</th> <th data-bbox="1150 837 1485 869">Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td data-bbox="453 875 790 994">Group projects (up to 3 people) / individual projects – students work on one of the proposed topics, create a presentation, and present it to the group.</td> <td data-bbox="799 875 1141 994">50.0%</td> <td data-bbox="1150 875 1485 994">40.0%</td> </tr> <tr> <td data-bbox="453 1001 790 1048">A midterm exam at the end of the semester</td> <td data-bbox="799 1001 1141 1048">50.0%</td> <td data-bbox="1150 1001 1485 1048">60.0%</td> </tr> </tbody> </table>	Subject passing criteria	Passing threshold	Percentage of the final grade	Group projects (up to 3 people) / individual projects – students work on one of the proposed topics, create a presentation, and present it to the group.	50.0%	40.0%	A midterm exam at the end of the semester	50.0%	60.0%		
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Recommended reading	<p>Basic literature</p>	<ol style="list-style-type: none"> 1. W. Kordecki: Probability Calculus and Mathematical Statistics. Definitions, Theorems, Formulas. 2. H. Jasiulewicz, W. Kordecki: Probability Calculus and Mathematical Statistics. Examples and Exercises. 3. I. Bąk, I. Markowicz, M. Mojsiewicz, K. Wawrzyniak: Statistics in Exercises. Part 1. Descriptive Statistics. 4. I. Bąk, I. Markowicz, M. Mojsiewicz, K. Wawrzyniak: Statistics in Exercises. Part 2. Mathematical Statistics. 5. W. Kryszwicki, J. Dyczka, K. Królikowska, M. Wasilewski: Probability Calculus and Mathematical Statistics in Exercises. Part 2. Mathematical Statistics. 6. A. Jokiel-Rokita, R. Magiera: Models and Methods of Mathematical Statistics in Exercises. 7. C. Radhakrishna Rao: Statistics and Truth. 8. W. Regel: 101 Exercises in Mathematical Statistics with Complete Solutions. 										
	<p>Supplementary literature</p>	<ol style="list-style-type: none"> 1. W. Regel: 101 Exercises in Mathematical Statistics with Complete Solutions. 										

	eResources addresses	<p>Supplementary</p> <p>https://www.stat.cmu.edu/~cshalizi/ADAfaEPoV/ADAfaEPoV.pdf - Cosma Rohilla Shalizi Advanced Data Analysis from an Elementary Point of View.</p> <p>https://www.impan.pl/~rzei/7ALL.pdf - RYSZARD ZIELIŃSKI: Seven Introductory Lectures to Mathematical Statistics This book provides a comprehensive introduction to mathematical statistics, covering essential topics and concepts.</p> <p>https://bdl.stat.gov.pl/bdl/pomoc - User Manual for BDL (Local Data Bank) The Local Data Bank (BDL) is Poland's largest database of the economy, society, and environment. It offers a wide range of statistical data and indicators, which are grouped thematically and updated regularly. The user manual provides detailed instructions on how to navigate and utilize the database effectively.</p>
Example issues/ example questions/ tasks being completed	<p>1. Discuss the methods of point and interval estimation. 2. What are the properties of a good estimator? 3. Explain the differences between parametric and non-parametric tests. 4. What are Type I and Type II errors? 5. How do you calculate the power of a test? 6. Present the linear regression model and discuss its applications.</p>	
Practical activities within the subject	Not applicable	

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