COURSE DESCRIPTION CARD - SYLLABUS

Course name
Statistical Methods in Scientific Research [S2IZarz1>MSwBN]

Course

Field of study
Engineering Management

Year/Semester
1/1

Area of study (specialization)
Managing Enterprise of the Future

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
0

Other (e.g. online)
0

Tutorials
15

Projects/seminars
0

Number of credit points

3,00

Coordinators

dr hab. Karol Andrzejczak prof. PP
karol.andrzejczak@put.poznan.pl

Lecturers

Prerequisites

1. The student has knowledge of mathematics in the field of mathematical analysis and probability theory and is able to use a calculator and statistical tables. 2. The student has the ability to think logically, associate facts, analyze issues and correctly reasoning. 3. The student is aware of the need to know the methods of data analysis when studying various subjects in the field of management engineering.

Course objective

The aim of the course is to learn the basic methods of mathematical statistics and to gain the ability to apply acquired knowledge to analyze problems in various fields, including technical

Course-related learning outcomes

Knowledge:
The student defines advanced statistical methods such as estimation, inference, hypothesis testing, and regression analysis, demonstrating their importance in scientific research [P7S_WG_02].
The student names a variety of qualitative and quantitative data collection and analysis techniques that are used in market and organizational research, and characterizes their application [P7S_WG_03].
The student describes methods of time series and cross-sectional analysis, cites their advantages and

limitations, and identifies their role in forecasting economic and social phenomena [P7S_WG_07].

Skills:
The student applies statistical methods to economic model, social and organizational phenomena and develop research strategies [P7S_UW_01].
The student uses statistical software to analyze data, interpret results and draw scientific conclusions [P7S_UW_02].
The student performs complex data analysis, including multivariate and econometric modeling, to identify trends and patterns of behavior [P7S_UW_06].
The student critically evaluates the quality and usefulness of data, identifies potential errors and applies appropriate techniques to correct them [P7S_UW_07].

Social competences:
The student integrates statistical methods with other scientific disciplines, creating interdisciplinary research projects [P7S_KK_01].
The student evaluates the importance and impact of statistical results on decision-making in organizations and public policy [P7S_KK_02].
The student demonstrates an awareness of the ethical aspects of data research, including the privacy of respondents and the interpretation of research results while respecting cultural and social diversity [P7S_KR_01].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

The basis for passing the lecture and exercises are: formative assessment for activities, bonuses for solving tasks during exercises and summative assessment.
1. Formative assessment for activity Max 50 points.
• Activity 1. 10 points. Solve 3 of the unsolved tasks from topic T02.
• Activity 2. 10 points. Solve 4 of the unsolved tasks from topic T03.
• Activity 3. 10 points. Among the unsolved tasks from topic T04, solve 3 tasks, including the summary task.
• Activity 4. 10 points. Among the unsolved tasks from topic T05, solve 4 tasks on various topics.
• Activity 5. 10 points. Solve 4 of the unsolved tasks from topic T06.

2. Bonus for solving the task during the exercises: Max 5 points. Maximum number of bonus points: 10 points.
3. Summative assessment. Final test at the final classes Max 50 points.
The final grade for the lecture and exercises is counted from the total number of points obtained.
Grading scale: dst from 50 points, dst plus from 60 points, db from 70 points, db plus from 80 points. very good from 90 points
The e-course is available in the catalog of the Institute of Mathematics. Independent registration to the group.

Programme content

Part 1. Probabilistics. Elements of probability calculus - random events, classical and axiomatic definition of probability, probability properties, conditional and total probability, Bayes formula. Random variables and their functional characteristics (cumulative distribution function (cdf), probability density function (pdf), probability function, quantile function) and their numerical characteristics (expected value, modal value, quartiles, quantiles, variance, standard deviation, ordinary and central moments, skewness and kurtosis). Properties and applications of the presented characteristics. Types of random variables. Uniform distribution, Bernoulli scheme, Bernoulli distribution, binomial distribution, uniform distribution, exponential distribution, normal distribution. Properties and applications of the presented probability distributions. Summary case study.
Part 2. Mathematical statistics. Basic concepts: population, random sample, representative sample, statistics as functions of random samples, positional statistics, dispersion statistics, correlation statistics. The essence of statistical research and inference. Theoretical distribution and empirical distribution from the sample. Point estimation, estimators and their good properties, estimation of an unknown parameter, estimation error. Theorem on the distribution of the arithmetic mean and the sum of elements of a random sample concerning a feature with a normal distribution. Central limit theorems for mean and sum. Application of the given theorems in decision-making. Student's t-distribution - its properties and

applications in statistics. Tables of quantiles of normal and Student's t-distribution. Distribution of the fraction of distinguished elements - de Moivre's theorem and its applications in statistics. Chi-square distribution and its application in the study of variance distribution. Two-sided and one-sided interval estimation for expected value, variance, standard deviation, and structure index in one and two populations. Determining the necessary sample size, while estimating the expected value that meets specific requirements. Statistical hypotheses and their systematization. The process of formulating and verifying a statistical hypothesis. Summary of statistical tests for expected value, variance and index of distinguished elements in one and two populations. Pearson's chi-square goodness-of-fit test. Goodness-of-fit test for polynomial distribution. Chi-square test of independence. Randomness test. Case study. Summary of a course on statistical methods in scientific research. Further directions in deepening knowledge of multivariate statistics.
Update: 28/05/2024

Course topics

T01: Random variables as models of the studied features
T02: Numerical characteristics of random variables
T03: Review of basic probability distributions used in statistics
T04: Probabilistic foundations of statistical inference
T05: Methods of estimating the parameters of the studied features
T06: Parametric significance tests
T07: Non-parametric significance tests

Teaching methods

Lectures are conducted in a classic, face-to-face or multimedia form. Some examples are solved in real time. Lecture materials in the form of presentations made available after the lecture. The lectures end with sets of tasks in Polish and English for students to solve on their own as part of scored activities. Solutions can be edited and solved with computer assistance.
Tutorials - discussion regarding the presentation of activities included in e-courses. Pointing out the good and bad sides of the solutions presented by students. Generalization of solved research problems.

Bibliography

Basic:
1. Jay L. Devore, Probability and Statistics for Engineering and the Sciences.
2. A.D. Aczel, Statystyka w zarządzaniu. Wydawnictwo Naukowe PWN, Warszawa.
3. D. Bobrowski, K. Maćkowiak-Łybacka, Wybrane metody wnioskowania statystycznego, Wyd. PP, Poznań 2004. (księg. stud. E1, W 51326).
4. W. Krysicki, J. Bartos, W. Dyczka, K. Królikowska i M. Wasilewski, Rachunek prawdopodobieństwa i statystyka matematyczna w zadaniach, cz. II, PWN Warszawa, 1986. (księg. stud. E1, W 60812/2)

Additional:
1. D. Bobrowski, Probabilistyka w zastosowaniach technicznych, Wydawnictwo Naukowo Techniczne.
2. K. Andrzejczak, Statystyka elementarna z wykorzystaniem systemu Statgraphics. Wyd. PP.
3. M. Sobczyk, Statystyka, Wydawnictwo Naukowe PWN, 2007. (1998 - księg. stud. A2, W 146934; 2007 - czytelnia).

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	45	2,00