THE DOCTORAL SCHOOL OF IPPT PAN

COURSE OFFERED IN THE DOCTORAL SCHOOL OF IPPT PAN

Name of the course	Polish	**Elementy statystyki matematycznej z zastosowaniami w R**				
	English	**Elements of mathematical statistics with applications in R**				
Type of the course	**Specialized course**					
Course coordinator	**Wasyl Kowalczuk, PhD, D.Sc.**		Course teachers	**Wasyl Kowalczuk, PhD, D.Sc. Ewa Eliza Rożko, PhD, D.Sc.**		
Implementing unit	**ZTOCiN**	Scientific discipline / disciplines	**Mechanical engineering**			
Level of education	**Doctoral studies**	Semester	**Winter or summer**			
Language of the course	**Polish**					
Type of assessment	**Examination**	Number of hours in a semester	**60**	ECTS credits	**4**	

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week	**2**	**2**	**0**	**0**	**0**
	in a semester	**30**	**30**	**0**	**0**	**0**

1. Prerequisites

The full understanding of the material presented in this course demands from the students at least the basic knowledge of probability theory and main concepts of statistical analysis.

2. Course objectives

The aim of this course is to acquaint the students with the basic concepts in analysis, interpretation, and presentation of scientific data with the help of an open source programming language R, which certainly is one of the most suitable software environments for statistical computing and graphical representation of the results of data analysis. During this course the theoretical overview of classical probability distributions, descriptive and inference statistics together with correlation and regression analysis will be given to enhance understanding of the formal numerical methods used in statistical analysis of the scientific data.

3. Course content (separate for each type of classes)

Lecture

Main topics:

1. Introduction to programming in R. From data to graphics.
2. Descriptive statistics: measures of central tendency (mean, median, mode), measures of variability/dispersion (standard deviation/variance, minimum/maximum values, quantiles, quartiles, interquartile range), measures of shape (skewness, kurtosis), scatter plots, histograms, box-and-whiskers plots.
3. Elements of probability theory: discrete/continuous probability distributions, cumulative distribution function, probability density function, law of large numbers, central limit theorem.
4. Statistical inference: hypotheses testing, test statistics, type I and type II errors, significance level, power of the test, parametric/non-parametric tests.
5. Estimation statistics: point and interval estimations, confidence intervals, population and sample effect sizes, sampling methods, sample size determination, precision of the estimate.
6. Correlaton analysis: Pearson correlation coefficient, Spearman's and Kendall tau rank correlation coefficients, correlation matrices, multiple correlation coefficient.

7. Regression analysis: linear/nonlinear regression models, assumptions, regression diagnostics, interpolation/extrapolation, power and sample size calculations, applications.
Laboratory
- does not apply

4. Learning outcomes			
Number of the learning outcome	Learning outcomes description	Reference to the learning outcomes according to the 8th level of PRK	Learning outcomes verification methods*
Knowledge			
1	The graduate acquires basic knowledge of main concepts in analysis, interpretation, and presentation of scientific data with the help of an open source programming language R.	P8S_WG	examination
2	The graduate knows how to apply the acquired knowledge to statistical computing and graphical representation of the results of data analysis, especially in the field of mechanical engineering.	P8S_WK	assessment of activity during auditory classes
Skills			
1	The graduate is able to solve practical problems in the field of mechanical engineering that demand understanding of the formal numerical methods used in statistical analysis of the scientific data.	P8S_UW	assessment of activity during auditory classes and examination
2	The graduate is able to apply the acquired knowledge directly to the field of his/her scientific research as well as disseminate the obtained results to the scientific community.	P8S_UW	assessment of activity during auditory classes
Communication			
1	The graduate is able to initiate a debate and participate in scientific discourse, as well as to provide appropriate arguments in scientific discussions and public debates on various topics.	P8S_UK	assessment of activity during auditory classes
Social competences			
1	The graduate is ready to think and act in a creative and entrepreneurial way.	P8S_KO	assessment of activity during auditory classes
2	The graduate is ready to critically evaluate the achievements of the represented scientific discipline, including his or her own contribution to the development of this discipline.	P8S_KK	assessment of activity during auditory classes

*Allowed learning outcomes verification methods: exam; oral exam; written test; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

5. Assessment criteria
Assessment of activity during auditory classes, result of final examination.

6. Literature
Primary references:
[1] T. Górecki, Podstawy statystyki z przykładami w R, Wydawnictwo BTC, Legionowo, 2011.
[2] P. Grzegorzewski, M. Gągolewski, K. Bobecka-Wesołowska, Wnioskowanie statystyczne z wykorzystaniem środowiska R, Program Rozwojowy Politechniki Warszawskiej, Warszawa, 2014.
Secondary references:
[1] O'Reilly, Język R. Kompletny zestaw narzędzi dla analityków danych, Helion S.A., Gliwice, 2018.
[2] P. Biecek, Przewodnik po pakiecie R, Oficyna Wydawnicza GiS, Wrocław, 2017.

7. PhD student's workload necessary to achieve the learning outcomes**		
No.	Description	Number of hours
1	Hours of scheduled instruction given by the lecturer in the classroom	**60**
2	Hours of consultations with the lecturer, exams, tests, etc.	**15**
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	**30**
4	Amount of time devoted to the preparation for exams, test, assessments	**15**
	Total number of hours	**120**
	ECTS credits	**4**

** 1 ECTS = 25–30 hours of the PhD students work (2 ECTS ≈ 60 hours; 4 ECTS ≈ 110 hours, etc.)