Course name: ***Statistical data analysis in water management with R program***

ECTS	6.0
Course status	*facultative*
Course final assessment /evaluation of outcomes	*exam*
Prerequisite	*Basic mathematical analysis*

Main field of study: ***Engineering and Water Management***

Educational profile	*General academic*
Code of studies and education level	*master of thesis*
Semester of studies	*summer*
Language of instruction	*English*

Course offered by:

Name of faculty offering the course	*Environmental Engineering and Land Surveying*
Name of department offering the course	*Applied Mathematics*
Course coordinator	*Agnieszka Rutkowska, Ph.D., Wojciech Młocek, Ph.D.*

Learning outcomes:

Symbol of outcome	Description of the learning outcome	Reference to main field of study outcomes	Area symbol*
KNOWLEDGE – student knows and understands:			
SWM_K1	*the basic concepts of probability, properties of random variables: the relationship between distributions, probability and cumulative distribution function (PDF, CDF), characteristics, typical distributions of random variables in hydrology and meteorology. Understands methods of analysis of empirical data and methods of statistical inference in water management issues. Understands statistical inference about extreme events in hydrology and meteorology: floods and droughts.*	*IGW2_W01*	*T*
SKILLS – student is able to:			
SWM_S1	*use the cumulative distribution function and density function to describe a random variable. Calculate its basic characteristics in the statistical package R. Identify and name typical random variables and distributions occurring in hydrology.*	*IGW2_U01* *IGW2_U02*	*T*
SWM_S2	*compute characteristics of the sample, apply various methods of estimation, compute quantiles in application to extreme events. Formulate parametric and nonparametric hypotheses in relation to problems of engineering and water management, use methods of correlation and regression analysis. Use the statistical package R for calculations.*	*IGW2_U01* *IGW2_U02*	*T*
SOCIAL COMPETENCIES – student is ready to:			
SWM_C1	*ready for further training based on literature in the field of statistical methods learned in engineering practice.*	*IGW2_K01*	*T*

Teaching contents

Lectures:	15 hours
Topics	*This is a course of statistical analysis with emphasis on problems in water management. Hydrological and meteorological variables are considered in applications. All exercises are carried out in R program – the modern environment for statistical computing. The course is recommended for students of Water Resources Engineering, Land and Water Management, Environmental Engineering. The requirement to enter the course is to finish the course in basic mathematical analysis.* 1. *Probability, random variable, cumulative distribution function (CDF), probability distribution function (PDF), characteristics: mean, variance, quantiles, skewness, kurtosis and others. Properties of the distribution functions of hydrological and meteorological variables. Extreme events: floods and droughts, flood frequency; probability of exceedance, return period.* 2. *Families of distribution functions in water management: Bernoulli, Poisson, Gaussian, Exponential, log-normal, Pearson 3, GEV, log-Pearson 3, Pareto and others.* 3. *Population, sample, descriptive statistics, sample distribution functions, sample characteristics. Plotting positions.* 4. *Statistical inference: confidence intervals for the mean, variance, fraction, the goodness of fit tests – the chi-squared, Kolmogorow-Smirnov, Shapiro-Wilk, Anderson-Darling, Cramer-von Mises, the tests of the mean, variance, fraction for one population and for two populations.* 5. *Correlation and regression analysis.* 6. *Time series analysis, tests for trend in hydrological and meteorological series.* 7. *Statistical nonparametric methods in water management.*
Accomplished learning outcomes	*SWM_K1; SWM_C1*
Means of verification, rules and criteria of assessment	*Passing the knowledge test (minimum 50% of correct answers to obtain the grade 3.0).* *Final grade is composed in 30% of this evaluation*
Classes:	30 hours
Topics	1. *Introduction to R: algebraic calculations, R objects: vectors, data frames, matrices, lists. Packages. Functions, loops. Graphical instructions.* 2. *Random variable, cumulative distribution function, probability distribution function (CDF, PDF), characteristics. Visualizing the plots of the distribution functions using the R instructions. Practical approach from the field of water management.* 3. *R functions for various families of distributions.* 4. *Descriptive statistics, practical approach to sample distribution functions and to sample characteristics using R instructions for hydrological and meteorological variables. Graphical visualization of data sample.* 5. *Statistics for extreme events from hydrology and meteorology. Flood frequency; probability of exceedance, return period.* 6. *Statistical inference with R: confidence intervals, tests for means, variances, fractions, goodness of fit tests, tests of goodness of fit. Practical approach from the field of water management with examples in R.* 7. *Correlation and regression analysis (linear, non-linear). Practical approach with examples in R.* 8. *Tests for trend in hydrological and meteorological time series.* 9. *Nonparametric statistics based on ranks for hydrological and meteorological variables.*
Accomplished learning outcomes	*SWM_S1; SWM_S2*

Means of verification, rules and criteria of assessment	*Completing each skill test for at least 50% of the points.* *Final grade is composed in 70% of this evaluation.*

References:

Basic	1. *Holický M. 2012. Introduction to Probability and Statistics for Engineers. Springer.* 2. *Field A., Miles J., Field Z. 2012. Discovering Statistics using R. Sage Publications.* 3. *Naghettini M. 2017. Fundamentals of Statistical Hydrology. Springer.*
Supplementary	1. *Tattar Prabhanjan, Ramaiah Suresh and Manjunath B.G. 2016. A Course in Statistics With R. Wiley.* 2. *Tilman M. Davies. 2016. The Book of R: A First Course in Programming and Statistics. No Starch Press.* 3. *McClave J.T., Sincich T. 2000. "Statistics", Upper Saddle River. Prentice Hall.*

Structure of learning outcomes

Area of academic study: R – Agricultural, forestry and veterinary sciences	0.0	ECTS **
Area of academic study: T – technical sciences	6.0	ECTS**

Structure of student activity

Contact hours	57	hrs.	2.3	ECTS**
Including: lectures	15	hrs.		
classes and seminars	30	hrs.		
consultations	10	hrs.		
participation in research	0	hrs.		
obligatory traineeships	0	hrs.		
participation in examination	2	hrs.		
e-learning	0	hrs.	0.0	ECTS**
student own work	93	hrs.	3.7	ECTS**

*Areas of academic study in the fields of: A – the arts; H – humanities; M – medical, sport and health sciences; N – natural sciences; P – biological sciences; R – agricultural, forestry and veterinary sciences; S – social studies; T – engineering and technology

** stated with an accuracy to 0.1 ECTS, where 1 ECTS = 25–30 hours of classes