FACULTY OF CIVIL ENGINEERING

SUBJECT CARD

Name in English: **Methods of applied statistics (geostatistics)**
Name in Polish: **Metody statystyki stosowanej (geostatystyka)**
Main field of study (if applicable): *Civil Engineering*
Specialization (if applicable): **Civil Engineering**
Level and form of studies: ~~1st /~~ **2nd level*, full-time** ~~/ part-time~~*****
Kind of subject: ~~obligatory /~~ **optional** ~~/ university-wide~~*****
Subject code: **CEB006963**
Group of courses: ~~YES /~~ **NO***

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	**15**			**15**	
Number of hours of total student workload (CNPS)	**30**			**60**	
Form of crediting	~~Examination~~ / crediting with grade *	Examination / crediting with grade *	Examination / crediting with grade *	~~Examination~~ / crediting with grade *	Examination / crediting with grade *
For group of courses mark (X) final course					
Number of ECTS points	**1**			**2**	
including number of ECTS points for practical (P) classes				**2,0**	
including number of ECTS points for direct teacher-student contact (BK) classes	**0,6**			**0,6**	

* delete as appropriate

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES
1. Possesses the knowledge required in the programme of secondary school, connected with mathematics and information science (computer science).
2. Possesses the knowledge concerning the mathematics, mathematical statistics and information science foundations.
3. Possesses the skills of basic making of mathematical statistics tools and basic information techniques.

SUBJECT OBJECTIVES
C1. Gaining of the knowledge concerning geostatistics foundations (grounds), representing the branch of applied (spatial) statistics, getting acquainted with basic descriptions, definitions and notions applied in geostatistics, such as for example: variogram, covariance, autocorrelation, variograms modeling, cross-validation, kriging, cokriging, interpolation, estimation, simulation, Gaussian models.
C2. Making acquaintance with basic models and techniques applied in linear stationary geostatistics and non-linear, non-stationary geostatistics.
C3. Forming up of skills of carrying out of multidimensional structural (variographic) analysis of variation of parameters (regionalized variables), describing the studied regionalized

phenomena and of performing of interpolation and estimation of averages values Z^* of these parameters, in regular elementary grid.

C4. Learning of carrying out of multidimensional structural analysis of variation of the studied phenomena and of using of interpolation and estimation techniques and performing of the evaluation of their applying meaning.

SUBJECT EDUCATIONAL EFFECTS
Relating to knowledge:
PEK_W01 Possesses the knowledge concerning an applied geostatistics foundations, taking into account of basic empirical measures of spatial variation and interpolation and estimation techniques, and also concerning their meaning in technical sciences and Earth sciences.
PEK_W02 Knows the foundations (grounds) of subject area (problems) related to the investigating of regionalized phenomena in various areas of knowledge (for instance: civil engineering, geodesy, mining, environment engineering, geology, environment protection) and he understands their meaning during the elaborating and the developing of area (2D), spatial and spatial-time (3D and 4D) geostatistical models.
Relating to skills:
PEK_U01 Knows how to carry out the evaluation of basic statistics and to calculate isotropic and directional variograms of the studied parameters and determine character and degree their variation, how to describe and characterize an anisotropy of variability of the considered parameters.
PEK_U02 Knows how to calculate variograms, block-diagrams, raster and isoline maps, and on the ground of maps he knows how to perform delineating grid sections along the sections lines, and moreover he knows how to carry out interpretation of the results of geostatistical analyses.
PEK_U03 Knows how to perform grid sections using the generated sets and how to carry out on their ground , for instance, an initial analysis of soil-water conditions for the needs of civil engineering or also geological-mining conditions for the needs of mining.
PEK_U04 Knows how to serve a specialistic geostatistical software, contained in special packet of geostatistical software and knows how to use adequate computer programs, how to copy, elaborate and interpret the results of spatial analyses (geostatistical studies) and how to prepare projects.
Relating to social competences:
PEK_K01 Knows how to work independently and together with team for the realizing of undertaken task.
PEK_K02 Knows how to use of the grounds of knowledge connected with obliging assumptions existing in geostatistics and how to use suitable analytical algorithms.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec1	Conditions of course crediting. Literature contents. Introduction to geostatistics, basic descriptions, definitions and notions (geostatistics, regionalized phenomena, variogram, covariance, autocorrelation, interpolation, estimation, simulation).	1
Lec2	Basic informations connected with theory of linear stationary geostatistics and non- linear and non-stationary geostatistics.	1
Lec3	Structural analysis of variation of the studied parameters using of variogram function, covariance function and autocorrelation function.	2
Lec4	Modeling of empirical variograms by means of analytical theoretical functions ("geostatistical models").	1
Lec5	Cross-validation of assumed theoretical models of empirical variograms.	1
Lec6	Investigating of an anisotropy of the studied parameters variation, using the directional variogram function.	1

Lec7	Estimating by applying with quick interpolation techniques and estimation techniques	3
Lec8	Geostatistical simulations	1
Lec9	Practical aspects of applying with kriging and simulation methods	1
Lec10	Fields (areas) of applications of geostatistical methods in country and abroad.	1
Lec11	Crediting colloquy	2
	Total hours	**15**

Form of classes - class	Number of hours
Cl1	
...	
Total hours	

Form of classes - laboratory	Number of hours
Lab1	Subject area scope. Literature contents. Priniciples of BHP. Conditions of course crediting. Admonition of basic geostatistical descriptions, definitions and notations. The elaborating of thematical data bases (2D, 3D), making the ground for geostatistical calculations.	1
Lab2	Geostatistical studies (2D, 3D) of geological-engineering parameters variation of soils and underground waters.	2
Lab3	Geostatistical studies (2D, 3D) of environmental and chemical parameters variation of underground waters.	2
Lab4	Integration of content of data bases containing geological-engineering and environmental parameters values, concerning soil-water environments, i.e soils and underground waters.	2
Lab5	Spatial analyses (2D, 3D) of parameters of mineral resources deposits variation.	2
Lab6	Processing and modeling of geological-mining parameters (data) in mining (3D).	2
Lab7	Non-stationary case study, presented for instance as an analysis of geological and seismic data.	2
Lab8	Images filtering presented for instance as an analysis of geological-engineering, environmental, climatical, deposit and material parameters.	1
Lab9	Course crediting	1
	Total hours	**15**

In the frame of the project – computer exercises (15 hours) with applying of the packet of statistical and geostatistical programs of ISATIS – the version of Isatis 2013.1, dongle key USB connected with the software Isatis purchased in the Firm Geovariances, Avon, Ecole des Mines de Paris, France.

Form of classes - project	Number of hours
Proj1	
…	
Total hours	

Form of classes - seminar	Number of hours
Sem1	
…	
Total hours	

TEACHING TOOLS USED		

N1. Lecture – Multimedial presentations. Word presentation. Explanation of some definitions on the black-board. Replying to requestions of students.

N2. Project (realized in computer laboratory) – carrying out of thematical projects on computers and reports on the ground of distributed didactic materials and the prepared data bases deriving from own sources (thematic data bases). Word and multimedial presentation, explanation of some definions on the black-board. Direct collaboration and discussion with Students.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1 (computer laboratory)	PEK_WO1, PEK_UO1	Average evaluation on the ground of projects.
F2 (computer laboratory)	PEK_WO1, PEK_UO1, PEK_KO1	Activity during courses.
F3 (computer laboratory)	PEK_WO1, PEK_UO1, PEK_KO1	Participation (presence) in project courses realized in computer laboratory.
F7 (lecture)	PEK_WO1, PEK_UO1	Colloquy
F8 (lecture)	PEK_WO1, PEK_UO1	Presence during lectures.
P (laboratory etc) =		
P (lecture) =		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:
[1] Armstrong M., Basic Linear Geostatistics. Berlin: Springer, 1998, s. 153.
[2] Armstrong M. & Dowd P. A. Editors. Geostatistical Simulations. Kluver Academic Publisher, Dordrecht, p.265, 1994.
[3] Chiles J. P., Delfiner P., Geostatistics: Modeling Spatial Uncertainity. N. Y.: Wiley,   (Wiley series in probability and statistics), 1999.
[4] Clark I. & Harper W.V., Practical Geostatistics 2000. Ecosse North America L1c Columbus Ohio, USA, p.342.
[5] Isaaks E., Srivastava R.Mohan, Introduction to Applied Geostatistics. New York Oxford, Oxford University Press, 1989.
[6] Lantuejoul C., Geostatistical Simulation, Models and Algorithms. Berlin: Springer,   2002.
[7] Namysłowska-Wilczyńska B., Geostatystyka Teoria – Zastosowania. Oficyna Wydawnicza Politechniki Wrocławskiej. Wrocław 2006 r., s. 265.
[8] Rivoirard J., Introduction to Disjunctive Kriging and Non-linear Geostatistics. Oxford: Clarendon, 1994.
[9] Wackernagel H., Multivariate Geostatistics, An Introduction with Applications. 2 nd edition, Springer – Verlag Berlin Heidelberg New York, 1998, s. 256.
SECONDARY LITERATURE:
[1] Deutsch C. & Journel A, 1998, GSLIB: Geostatistical Software Library and User's   Guide. Oxford University Press, New York, Oxford. p. 369.
[2] ISATIS, Isatis Software Manual. Geovariances & Ecole des Mines de Paris, Avon Cedex, France, January 2001, s. 585.
[3] Mucha J.: Metody geostatystyczne w dokumentowaniu złóż., Akademia Górniczo- Hutnicza,

Wydział Geologii, Geofizyki i Ochrony Środowiska, Katedra Geologii Kopalnianej, Kraków 1994., s. 155.

[4] Mucha J.: Struktura zmienności zawartości [Zn] i [Pb] w Śląsko-Krakowskich złożach rud Zn-Pb. Studia, Rozprawy, Monografie nr 108, Wydawnictwo Instytutu Gospodarki Surowcami Mineralnymi i Energią PAN, Kraków 2002, s. 149.

[5] Namysłowska-Wilczyńska B., Zmienność złóż rud miedzi na monoklinie przedsudeckiej w świetle badań geostatystycznych. Prace Naukowe Instytutu Geotechniki i Hydrotechniki Politechniki Wrocławskiej 64, Seria: Monografie 21, Wrocław 1993, s. 207.

SUBJECT SUPERVISOR (NAME AND SURNAME, DIVISION, E-MAIL ADDRESS)

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Methods of applied statistics (geostatistics)
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY *Civil Engineering*
AND SPECIALIZATION **Civil Engineering**

Subject educational effect	Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable)**	Subject objectives ***	Programme content ***	Teaching tool number ***
Knowledge				
PEK_W01	K2_W01, K2_W09, K2S_CEB_W22	C1,C2,C3,C4	Lec1- Lec8 Proj1-Proj7	N1, N2
PEK_W02	K2_W01, K2S_CEB_W22	C1,C2,C3,C4	Lec1- Lec8 Proj1-Proj7	N1, N2
Skills				
PEK_U01	K2_U01, K2S_CEB_U23	C1,C2	Lec1-W Lec6 Proj1-Proj7	N1, N2
PEK_U02	K2_U03, K2S_CEB_U23	C1-C3	Lec2- Lec8 Proj1-Proj7	N1, N2
PEK_U03	K2_U08, K2_U17, K2S_CEB_U23	C1-C3	Lec7- Lec9 Proj1-Proj7	N1, N2
PEK_U04	K2_U16, K2_U17, K2S_CEB_U19, K2S_CEB_U23	C1-C4	Lec2- Lec10 Proj1-Proj7	N1, N2
Social competence				
PEK_K01	K2_K01, K2_K02, K2_K03, K2_K06	C1-C2	Lec1- Lec7 Proj1-Proj7	N1, N2
PEK_K02	K2_K01, K2_K02, K2_K03, K2_K06	C3-C4	Lec4- Lec10 Proj1-Proj7	N1, N2

** - enter symbols for main-field-of-study/specialization educational effects
*** - from table above