FACULTY OF CIVIL ENGINEERING

SUBJECT CARD

Name in English: **Selected topics in geo-engineering – Foundations**
Name in Polish: **Wybrane zagadnienia geoinżynierii – Fundamenty**
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: **CEB007361**
Group of courses: ~~**YES**~~ **/ NO***

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	**15**			**30**	
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	**0,5**			**1,2**	

*cross out if not applicable

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

P1. Fundamentals of bearing constructions in civil engineering, fundamentals of strength of materials and soil mechanics.
P2. Basic types of foundations for different simple geoengineering conditions, geotechnical categories GC1 and GC2, construction processes of foundations, functional and environmental aspects of foundations depending on the type of object, loadings, soil conditions and water in soils.
P3. Principles of soil-structure interacion for undeformable foundations, embedded walls, retaining structures; calculation of the bearing capacity, stability of slopes, calculation of soil and water pressure.
P4. Design of basic concrete elements, like beams, footings and columns; reinforcement calculation.
P5. Solving of the simplest linear ordinary differential equations with constant coefficients.

SUBJECT OBJECTIVES

C1. Ability in modelling of the soil-structure interaction for deformable foundations on deformable subsoil; contact stresses redistribution, changes of internal forces, mining influences as a static excitation.
C2. Knowledge of mathematical solutions to simple deformable foundations on the elastic subsoil, the Winkler model and the elastic halfspace; application of differential equations.
C3. Building an engineering intuition in prediction of internal forces in foundations, non-uniform

settlements and rational analysis of structures interacting with the subsoil.

C4. Gaining knowledge in more complex problems of the earth pressure prediction, generalizations of the Coulomb solution.

C5. Developing knowledge and ability of application of methods of the earth pressure reduction, stability improvement, shaping of retaining walls.

C6. Understanding necessity of safety in geotechnical design – design approaches with partial safety factors due to the Eurocode EC7-1.

C7. Developing skills in design of foundations.

SUBJECT EDUCATIONAL EFFECTS	
Relating to knowledge:	
PEK_W01	student gains a theoretical knowledge in applications of ordinary differential equations towards calculation of deformable foundation beams, as well as piles and walls embedded in soils, a better understanding of the method of virtual forces (the Bleich method) - being a prototype for the boundary element method,
PEK_W02	understands a theoretical background of the method of partial safety factors in geoengineering, uses the design approaches required by the Eurocode EC7-1 – the GEO stability criteria in this group,
PEK_W03	understands problems of soil-structure interaction on the example of elastic subsoils, knows how to design retaining constructions transmitting large loadings on the soil – particularly non-vertical forces, gets a background to identify poor engineering solutions,
Relating to skills:	
PEK_U01	student can define and apply appropriate calculation models for deformable foundations and deformable soils, analyses internal forces in foundations and combinations of such actions (also for mining excitations),
PEK_U02	can interpret the special role played by elastic fixities of constructions in the soil, is aware of fundamental shortcomings in commercial codes of CAD for CE designers,
PEK_U03	becomes skillful in modelling of the soil-structure interaction problems, can calculate more complex foundations within the geotechnical category 2 and 3,
Relating to social competences:	
PEK_K01	student improves the ability to work alone and in a group of designers (due to discussions with other students during class-projects and with the teacher),
PEK_K02	drills in logical thinking, clear formulation of theses and requirements, concentration on given tasks – within a given theory and set margins of assumptions.

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec1	Examples of the soil-foundations interaction: Role of the foundation stiffness, influence of a superstructure stiffness and the subsoil compressibility on contact forces and structural behaviour	1
Lec2	Linear calculation models of the subsoil compressibility: Global models – the Winkler subsoil, the Pasternak one, the Kerr one *etc.*, local models – the elastic halfspace, finite elastic layers; rational selection of the most adequate linear model, real-soil behaviour and application limits of the linear models	1
Lec3	Calculation of simple foundations resting on the linear elastic subsoil: Foundation beams – the fundamental solution, the basic solutions, boundary conditions, the method of Bleich (virtual forces applied outside the real beam), the method of polynomial expansions by Zavrijev; beams, piles, walls, foundation grids, foundation slabs	2

Lec4	Elements of the mining geoengineering: Types of mining deformations and the prediction methods, parameters of the ground surface subsidence, mining categories, tolerance of engineering objects to deformations, the simplest construction principles; practical examples	3
Lec5	Types and construction of retaining structures: Massive (gravity) retaining walls, light (cantilever) retaining walls, structures embedded in soil, reinforced-soil retaining structures; general stability criteria ULS(GEO) and SLS due to Eurocode EC7-1	1
Lec6	Earth pressure theories: The Coulomb-Mohr solutions, the Rankine-Mohr approach, the Coulomb-Poncelet method for the active earth pressure, the Coulomb-Poncelet method for the passive earth pressure, the Müller-Breslau expressions, the Rankine-Mohr approach, the Prandtl solution; the Caquot & Kerisel charts (EC7-1)	3
Lec7	Practical cases of the earth pressure calculations: Angular cantilever walls; role of cohesion - the method of corresponding states of stresses; bearing capacity GEO against the soil heave **Final test #1 (45min)**	2
Lec8	Geoengineering faults and failures: Insufficient geotechnical data, misinterpretation of soil behaviour, design errors, not correct construction processes, unexpected changes of conditions and poor recognition of environmental influences, faults during the repair/rescue action; A case history – The Leaning Tower of Pisa. **Final test #2 (45min)**	2
	Total hours	**15**

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

Form of classes - laboratory		**Number of hours**
Lab1		
…		
	Total hours	

Form of classes - project		**Number of hours**
Proj1	Design Project #1 – Foundation beam on a mining area: analysis of the situation, project data, calculation methods	1
Proj2	foundation length estimation (linear soil reaction, beam bending moments)	1
Proj3	foundation width estimation (ULS-GEO), shaping of the beam cross section	2
Proj4	Selection of the soil model, estimation of model parameters, solving of the infinite beam for the acting forces	3
Proj5	Solving of the finite beam – the use of the Bleich virtual forces	3
Proj6	analysis of mining deformations and mining forces	2
Proj7	concrete design; construction drawings	2
Proj8	Project defense/project acceptance - an evaluation test	2
Proj9	Design Project # 2 – Cantilever retaining wall: analysis of the situation, project data, input shaping, setting of loadings	2

Proj10	the Rankine earth pressure, checking of the stability ULS-GEO	2
Proj11	the Poncelet earth pressure, checking of the stability ULS-GEO	2
Proj12	concrete design of the wall and the foundation slab (cantilevers)	2
Proj13	construction details, construction drawings	2
Proj14	Project defense/project acceptance - an evaluation test	2
Proj15	final acceptance	2
	Total hours	**30**

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

TEACHING TOOLS USED
N1. Lecture: recalling practical examples from geotechnical expertise, sketches and drawings. N2. Lecture and Project: more complex calculation examples can be downloaded from the author's web site [5]. N3. Project: individual consulting, discussion of problems in a group of students. N4. List of problems and calculation tasks for a self-study can be downloaded from the author's web site [5] – some of them are accompanied by hints, answers or full solutions.

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 (Project)	PEK_W01 PEK_W02 PEK_W03 PEK_U01 PEK_U03 PEK_K01 PEK_K02	Systematical – every week – checking of the student's progress during classes and consulting hours
P1 (Project)	PEK_W01 PEK_W02 PEK_W03 PEK_U01 PEK_U03 PEK_K01 PEK_K02	Final defense of each of two projects; detailed questions about the project, discussion of student's errors or mistakes; project corrections and improvements.
P1 (Lecture)	PEK_W01 PEK_W02 PEK_W03 PEK_U01 PEK_U02 PEK_U03 PEK_K02	Two final tests during two last lectures; wide spectrum of questions and calculation tasks (theoretical, practical, interdisciplinary and holistic ones)

PRIMARY AND SECONDARY LITERATURE
PRIMARY LITERATURE: [1] Bond A., Harris A., Decoding Eurocode 7. *Taylor & Francis*, 2008. [2] Cernica J., Geotechnical engineering: Foundation design. *John Wiley & Sons*, 1995. [3] Henry J., Foundation engineering, 1990. [4] Lancellotta R., Geotechnical engineering, *A.A. Balkema*, 1995*; Spon Press*, 2008. [5] Reese L.C., Isenhower W.M., Wang S.-T., Analysis and design of shallow and deep foundations. *John Wiley & Sons*, 2006. [6] Eurocode EC7-1. Geotechnical design, Part 1. **[7]** www of world-leading foundation companies. **SECONDARY LITERATURE:** [1] Selvadurai A.P.S., Elastic analysis of soil-foundation interaction, *Elsevier*, 1979. [2] Other Eurocodes and national codes in CE. [3] http://www.ib.pwr.wroc.pl/brzakala

SUBJECT SUPERVISOR (NAME AND SURNAME, DIVISION, E-MAIL ADDRESS)
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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Selected topics in geo-engineering – Foundations
AND EDUCATIONAAL 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, K2S_CEB_W16	C1, C2, C7	Lec1-Lec3	N2-N4
PEK_W02	K2_W06, K2S_CEB_W20	C4-C6	Lec5 Proj3 Proj10-Proj12	N2-N4
PEK_W03	K2_W08, K2S_CEB_W19	C1-C5	Lec1-Lec8 Proj1-Proj15	N1-N4
Skills				
PEK_U01	K2_U04, K2_U05, K2S_CEB_U20	C2, C4, C6, C7	Lec1-Lec8 Proj1-Proj15	N1-N4
PEK_U02	K2_U09, K2_U16, K2S_CEB_U22	C1-C3	Lec1-Lec8 Proj1-Proj15	N1
PEK_U03	K2_U10, K2_U17, K2S_CEB_U23	C2, C4, C7	Proj1-Proj15	N2, N4
Social competence				
PEK_K01	K2_K03	C2, C4, C7	Proj1-Proj15	N2-N4
PEK_K02	K2_K06	C1-C6	Proj1-Proj15 Lec1-Lec8	N1-N4

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