Zał. nr 4 do ZW 64/2012

FACULTY OF CIVIL ENGINEERING

SUBJECT CARD

Name in English:	**Underground structures – urban infrastructure**
Name in Polish:	**Budownictwo podziemne – infrastruktura miejska**
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:	**CEB003962**
Group of courses:	**~~YES~~ / NO***

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	**30**			**30**	
Number of hours of total student workload (CNPS)	**60**			**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	**2**			**2**	
including number of ECTS points for practical (P) classes				**2,0**	
including number of ECTS points for direct teacher-student contact (BK) classes	**1,0**			**1,2**	

* delete as appropriate

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES
1. The student possesses knowledge of structural mechanics.
2. The student knows the principles of soil mechanics with relation to civil engineering.
3. The student knows standards of concrete structure designing.

SUBJECT OBJECTIVES
C1. Learning the principles of interaction: tunnel support – surrounding rock mass
C2. Gaining the different types of underground structures and various executing technologies.
C3. Skills acquisition of design of reinforced concrete tunnel support.
C4. Skills acquisition of advanced design of tunnel support located at great depth
C5. Skills acquisition of solving, interpreting and verifying of the results of analytical calculations.
C6. Strengthening the ability to work on the task entrusted to and awareness of the need to seek new theoretical and practical solutions.

SUBJECT EDUCATIONAL EFFECTS	
Relating to knowledge:	
PEK_W01	Student has an in-depth knowledge of analysis, design and construction of underground structures in urban infrastructure.
PEK_W02	Student has an in-depth knowledge of rock mechanics and tunnel support design.
Relating to skills:	
PEK_U01	The student can properly create a computational model of underground structure.
PEK_U02	The student can properly design all the elements of underground structure.
Relating to social competences:	
PEK_K01	The student can works independently or with a team..
PEK_K02	The student is aware of the need to continuously increase own knowledge in the field of design techniques of underground structures.

PROGRAMME CONTENT		
	Form of classes - lecture	**Number of hours**
Lec1	Introduction - the basic definition and classification of underground urban infrastructure.	2
Lec2	Designing of shallow underground structures.	2
Lec3	Loads acting on shallow underground structures.	2
Lec4	Loads acting on shallow underground structures – further information.	2
Lec5	Executing technologies of shallow tunnels	2
Lec6	Trenchless technologies of shallow tunnels execution	2
Lec7	Specific features of deep tunnels. Advanced ventilation systems of long and deep tunnels..	2
Lec8	Longitudinal profile of deep tunnels and its implication for drainage and ventilation facility.	2
Lec9	Advanced systems of waterproofing of tunnel structure	2
Lec10	Critical depth. Estimating the value of critical depth for excavation located in rock mass governed by: a) Coulomb - Mohr or b) Hoek – Brown failure criterion.	2
Lec11	Deformation earth pressure. The elastic-plastic problem of circular excavation at great depth - Part I: elastic deformation.	2
Lec12	Deformation earth pressure. The elastic-plastic problem of circular excavation at great depth - Part II: plastic deformation.	2
Lec13	Static earth load acting on tunnel support. Engineering methods for assessing static rock pressure. Role of tunnel support mechanical characteristics on rock-tunnel support interaction.	2
Lec14	Parametric evaluation of the quality of the rock mass. Geomechanics classifications: RQD, RMR, Q, GSI.	2
Lec15	New Austrian tunneling method	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	Presentation of the scope of the project, the completion and the available literature. Discussion of the design scope.	2
Proj2	Principles of cross-section design of tunnel support - Car tunnel. Discussion on methods of waterproofing of tunnel structure. Individual students work on projects.	2
Proj3	Principles of cross-section design of tunnel support - railway tunnel. Individual students work on projects.	2
Proj4	Practical use of geomechanics classification of rock mass: RMR and GSI	2
Proj5	Presentation of Hoek-Brown failure criterion. Relations enabling estimations of failure criterion parameters based on the GSI classification. Estimation of critical depth.	2
Proj6	The elastic-plastic boundary value problem of circular excavation at great depth: elastic and elastic-plastic solution. Rock mass pressure acting on tunnel support as a function of plastic zone radii.	2
Proj7	The value of rock mass pressure corresponding to maximum radii of plastic zone.	2
Proj8	Verification of the student calculations of rock mass pressure acting on tunnel support.	2
Proj9	Computational model of static interaction in the system: tunnel support – rock mass. Evaluation of parameters of computational model.	2
Proj10	Strength designing of concrete tunnel support.	2
Proj11	Discussion on the students final design of tunnel support and verification of the internal forces of tunnel structure evaluated by students.	2
Proj12	Principles of proper ventilation preservation in tunnel: Pulsfort and Bendelius method.	2
Proj13	The problem of preserving the safety in tunnel. Elements of additional equipment in tunnel.	2
Proj14	Drilling and blasting technologies in tunnel excavation execution.	2
Proj15	Presentation of the final design of tunnel support.	2
	Total hours	**30**

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

TEACHING TOOLS USED
N1. Lecture: classic lecture and multimedial presentations N2. Project: solving of calculation example, multimedial presentation,

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_U01, PEK_U02, PEK_K01	Partial evaluation of students design of tunnel support
F2 (Project)	PEK_U01, PEK_U02, PEK_K01	Presentation of the final tunnel design.
P = 0,5xF1+0,4xF2+0,1xPARTICIPATION (projekt)		
F1 (lecture)	PEK_W01, PEK_W02, PEK_K02	Exam

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Bieniawski Z. T.: „Engineering Rock Mass Classifications", Wiley, 1989.
[2] Hoek E.: Support of underground excavations in hard rock, 1995.
[3] Megaw T.M.: Tunnels: planning, design, construction, 1983.
[4] Kolymbas D.: Tunneling and tunnel mechanics: a rational approach to tunneling, 2005.

SECONDARY LITERATURE:

[1] Lunardi P.: Design and construction of tunnels, 2008.

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

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DIDACTIC TEAM MEMBERS (NAME AND SURNAME, DIVISION, E-MAIL ADDRESS)

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
Underground structures – urban infrastructure
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_W05, K2_W06, K2_W11, K2S_CEB_W20, K2S_CEB_W21	C2, C3	Lec1 – Lec6	N1
PEK_W02	K2_W05, K2_W11, K2_W13, K2S_CEB_W21	C1, C2, C3	Lec7- Lec15	N1
Skills				
PEK_U01	K2_U04, K2_U05, K2_U07, K2S_CEB_U19, K2S_CEB_U22	C3, C4, C5, C6	Proj2 - Proj7, Proj8 - Proj10, Proj12 - Proj14	N2
PEK_U02	K2_U06, K2_U07, K2_U09, K2_U12, K2S_CEB_U19, K2S_CEB_U22	C3, C4, C5, C6	Proj2 - Proj7, Proj8 - Proj10, Proj12 - Proj14	N2
Social competence				
PEK_K01	K2_K03	C5	Proj2 - Proj5, Proj7, Proj9, Proj13, Proj14	N2
PEK_K02	K2_K01	C6	Proj1, Proj4, Proj8, Proj11, Proj13, Proj14	N2

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