

**FACULTY OF CIVIL ENGINEERING**

**SUBJECT CARD**

<b>Name in English:</b>	<b>Underground structures – urban infrastructure</b>
<b>Name in Polish:</b>	<b>Budownictwo podziemne – infrastruktura miejska</b>
<b>Main field of study (if applicable):</b>	<b>Civil Engineering</b>
<b>Specialization (if applicable):</b>	<b>Civil Engineering</b>
<b>Level and form of studies:</b>	<b><del>1st</del> / 2nd level*, full-time / <del>part-time</del>*</b>
<b>Kind of subject:</b>	<b>obligatory / <del>optional</del> / <del>university-wide</del>*</b>
<b>Subject code:</b>	<b>CEB003962</b>
<b>Group of courses:</b>	<b><del>YES</del> / NO*</b>

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

\* 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.

<b>SUBJECT EDUCATIONAL EFFECTS</b>	
<b>Relating to knowledge:</b>	
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.
<b>Relating to skills:</b>	
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.
<b>Relating to social competences:</b>	
PEK_K01	The student can work 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.

<b>PROGRAMME CONTENT</b>		
<b>Form of classes - lecture</b>		<b>Number of hours</b>
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
<b>Total hours</b>		<b>15</b>

<b>Form of classes - class</b>		<b>Number of hours</b>
Cl1		
...		
<b>Total hours</b>		

<b>Form of classes - laboratory</b>		<b>Number of hours</b>
Lab1		
...		
	<b>Total hours</b>	

<b>Form of classes - project</b>		<b>Number of hours</b>
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
	<b>Total hours</b>	<b>30</b>

<b>Form of classes - seminar</b>		<b>Number of hours</b>
Sem1		
...		
	<b>Total hours</b>	

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

<b>EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT</b>		
<b>Evaluation</b> 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

<b>PRIMARY AND SECONDARY LITERATURE</b>
<b><u>PRIMARY LITERATURE:</u></b> [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.
<b><u>SECONDARY LITERATURE:</u></b> [1] Lunardi P.: Design and construction of tunnels, 2008.

<b>SUBJECT SUPERVISOR (NAME AND SURNAME, DIVISION, E-MAIL ADDRESS)</b>
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<b>DIDACTIC TEAM MEMBERS (NAME AND SURNAME, DIVISION, E-MAIL ADDRESS)</b>
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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 ***
<b>Knowledge</b>				
<b>PEK_W01</b>	K2_W05, K2_W06, K2_W11, K2S_CEB_W20, K2S_CEB_W21	C2, C3	Lec1 – Lec6	N1
<b>PEK_W02</b>	K2_W05, K2_W11, K2_W13, K2S_CEB_W21	C1, C2, C3	Lec7- Lec15	N1
<b>Skills</b>				
<b>PEK_U01</b>	K2_U04, K2_U05, K2_U07, K2S_CEB_U19, K2S_CEB_U22	C3, C4, C5, C6	Proj2 - Proj7, Proj8 - Proj10, Proj12 - Proj14	N2
<b>PEK_U02</b>	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
<b>Social competence</b>				
<b>PEK_K01</b>	K2_K03	C5	Proj2 - Proj5, Proj7, Proj9, Proj13, Proj14	N2
<b>PEK_K02</b>	K2_K01	C6	Proj1, Proj4, Proj8, Proj11, Proj13, Proj14	N2

\*\* - enter symbols for main-field-of-study/specialization educational effects

\*\*\* - from table above