Annex No. 9
to the Rector's Decision No. 35/19
as amended by Decision No. 12/22

COURSE SPECIFICATION

Course code	full-time:	**B1-6-TiOB-608, B1-7-TiOB-707**
	part-time:	**BN1-7-TiOB-709**
Course title in Polish	**Technologia Betonów Mrozoodpornych 1 Technologia Betonów Mrozoodpornych 2 Technologia Betonów Mrozoodpornych 1 and 2**	
Course title in English	**Technology of Frost-Resistant Concretes**	
Valid from academic year	**2023/2024**	

CURRICULAR ALIGNMENT

Programme	**CIVIL ENGINEERING**
Level	**first-cycle**
Programme profile	**academic**
Mode of attendance	**full-time; part-time**
Specialism	**Construction Technology and Project Management**
Academic unit responsible for the course	**Department of Construction Technology and Management**
Course coordinator	**prof. dr hab. inż. Jerzy Wawrzeńczyk**
Approved by	**prof. dr hab. inż. Grzegorz Świt**

COURSE DESCRIPTION

Teaching block		**specialism specific**
Course status		**required**
Language of instruction		**Polish**
Semester of delivery	full-time	**semester VI, semester VII**
	part-time	**semester VII**
Prerequisites		**Technology of Concrete, Technology of Concrete Work**
Exam (YES/NO)		**NO**
ECTS		**2**

Mode of teaching		**lecture**	**class**	**lab**	**project**	**other**
Number of hours per semester	full-time:	**15**		**15**		
	part-time:	**10**		**10**		

LEARNING OUTCOMES

Category	Code	Learning outcomes	Corresponding programme outcome code
Knowledge	W01	Students know and understand the basic physical mechanisms responsible for the displacement, accumulation, and phase transformations of water in the pores of concrete.	B1_W01 B1_W13 B1_W18 B1_W19
	W02	Students have a general knowledge of the frost-resistant concretes design, application scope, and test methods.	B1_W08 B1_W13 B1_W18 B1_W19
Skills	U01	Students can design a concrete mix that meets the requirements for frost-resistant structures.	B1_U24
	U02	Students can carry out tests on concrete mixture for air-entrainment, physical characteristics, and frost resistance of concrete.	B1_U23
Competence	K01	Students can see the systemic and economic aspects of an engineering task when formulating and solving it.	B1_K01

COURSE CONTENT

Teaching mode*	Topics covered
lecture	Classification of frost damage of concrete structures. Structural and climate-related determinants of frost durability of structural elements. Overview of the EN 206 standard.
	Properties of free and adsorbed water. Structure of water, its surface tension, density, viscosity, and phase transformations; properties of ice.
	Origin and geometrical characteristics of pores in concrete. Movement and accumulation of water in concrete: diffusion, adsorption, physical condensation, capillary pressure
	Freezing and thawing of water in the pores of concrete. Effect of de-icing salts (NaCl) on the change of water absorption and freezing conditions.
	Effect of W/C ratio on frost resistance; production of frost-resistant concretes without aerating agents or microspheres.
	Air-entrainment of concrete mixtures; air-entrainment methods and agents; air pore characteristics and its formation, the coefficient of spatial distribution of pores.
	Types of aggregates and cements in the context of suitability for frost-resistant concretes. Methods of testing concrete mixtures and hardened concretes.
lab	Health and Safety Training.
	Indication of suitable operating and environmental conditions for concrete. Determination of the requirements for concrete mix in strictly defined operational conditions, selected individually**.**
	Methods of designing concrete with the required frost resistance.
	Quantitative and qualitative selection of components for concrete with the required frost resistance (cement, aggregate, admixtures, additives, mixing water).
	Preparing of a series of reference concretes based on developed formulas, air-entrained conventionally and with the addition of polymer microspheres. Applying selected test methods for concrete mixture air-entrainment.
	Selection of methods and procedures for controlling the frost resistance of concrete (European, American and Scandinavian standards), performance of tests for the physical characteristics and frost resistance of a series of concretes.

METHODS OF LEARNING OUTCOMES VERIFICATION

Learning outcome	Learning outcome verification methods					
	Oral exam	Written exam	Test	Project	Report	Other
W01			X			
W02			X	X		
U01				X	X	
U02				X	X	
K01				X	X	

ASSESSMENT

Teaching mode*	Assessment type	Criteria
lecture	mark-based	*Scoring at least 50% of the points from the test.*
lab	mark-based	*Correct execution of the project and obtaining at least 50% of the points from the project defense. Obtaining at least 50% of the points from the test.*

STUDENT WORKLOAD

ECTS weighting												
	Activities	Student workload										
		full-time					part-time					
1.	Scheduled contact hours	W	C	L	P	S	W	C	L	P	S	h
		15		15			10		10			
2.	Other (office hours, exams)	2		2			2		2			h
3.	**Total number of contact hours**	**34**					**24**					h
4.	**Number of ECTS credits for contact hours**	**1,4**					**1**					ECTS
5.	**Independent study hours**	**16**					**26**					h
6.	**Number of ECTS credits for independent study**	**0,6**					**1**					ECTS
7.	**Practical hours**	**25**					**25**					h
8.	**Number of ECTS credits for practical hours**	**1**					**1**					ECTS
9.	**Total workload**	**50**					**50**					h
10.	**ECTS credits for the course** *1 ECTS credit =25 student learning hours*	**2**										

READING LIST

1. Wawrzeńczyk J.: Metody badania i prognozowania mrozoodporności betonu – Kielce, 2017.
2. Pigeon M., Pleau R.: Durability of concrete in cold climates. E & FN SPON, London, 1995.
3. Neville A. M.: Właściwości betonu. Polski Cement, Kraków, 2000.
4. Kurdowski W.: Chemia cementu i betonu. Wydawnictwo Polski Cement & PWN, Warszawa, 2010.
5. Rusin Z.: Technologia betonów mrozoodpornych. Wydawnictwo Polski Cement, Kraków 2002

6. Peukert S.: Cementy powszechnego użytku i specjalne. Wydawnictwo Polski Cement, Kraków 2000.
7. Praca zbiorowa pod kierunkiem L. Czarneckiego, Beton według normy PN-EN 206-1- komentarz. Polski Cement & PKN, Kraków, 2007.
8. Fagerlund G.: Trwałość konstrukcji betonowych. Arkady, 1997.