



COURSE CARD

1. Basic information

Course name in English:	Life Cycle Analysis of Materials, Structures and Buildings	
Course name in Polish:	Analiza cyklu życia materiałów, konstrukcji i budynków	
Number of hours:	30	
Type of course:	Elective course	
Form of course:	lecture	
Code of course:		
Course leader:	Dr hab Vsevolod Nikolaiev, profesor uczelni	
Faculty of the course leader:	W2 Faculty of Civil Engineering	
Email address of the course leader:	vsevolod.nikolaiev@pwr.edu.pl	
Scientific discipline(s) assigned to the course (doctoral students representing the marked disciplines can participate in the course):	Architecture and urban planning	<input checked="" type="checkbox"/>
	Automation, electronic, electrical engineering and space technologies	<input type="checkbox"/>
	Information and communication technology	<input checked="" type="checkbox"/>
	Biomedical engineering	<input type="checkbox"/>
	Chemical engineering	<input type="checkbox"/>
	Civil engineering, geodesy and transport	<input checked="" type="checkbox"/>
	Materials engineering	<input checked="" type="checkbox"/>
	Mechanical engineering	<input type="checkbox"/>
	Environmental engineering, mining, and energy	<input checked="" type="checkbox"/>
	Mathematics	<input type="checkbox"/>
	Chemical sciences	<input type="checkbox"/>
	Physical sciences	<input type="checkbox"/>
Management and quality studies	<input checked="" type="checkbox"/>	

2. Objectives

The holistic approach to engineering, design, construction and real estate management based on Life Cycle Analysis, is a new field of knowledge, which forms an innovative methodology and tool. Therefore, we estimate that our course would be interesting and useful for doctoral students as researchers of new materials and structures, designers of new buildings - who are going to expand their point of view on engineering by adding to their investigation the additional stages of operation and maintenance of building objects. The conjugate subjects such as architecture, information modeling and sustainability would be taken into account. This course will be interesting as well because of its coverage of different types of facilities during their life cycle period, especially concerning industrial, public real estate and housing. The course is based on both "classical" literature and lecturer's scientific publications and practical experience.

3. Content

Detailed information about the course content, including topics and form of classes.



No.	Topic	Number of hours	Form of classes
1	Definition of the life-cycle, introduction to the course 1.1. Detailed description of the course. 1.2. Presentation and the selection of seminar case studies 1.3. Definition of the life-cycle of the product 1.4. Division of the periods during product life cycle 1.5. Various approaches of the life-cycle assessment	2	lecture
2	Definitions and classifications in life cycle analysis of building object 2.1. Materials, structures, object under construction, real estate, real property. 2.2. Classification of real property objects. 2.3. Basics domains of design, construction, maintenance and operation analysis. 2.4. BIM. Structural elements approach. 2.5. Assets analysis.	2	lecture
3	Concept and methodology of life-cycle analysis. 3.1. Genesis of Life Cycle Analysis (LCCA, WLA) 3.2. Informational and methodical support of life cycle analysis. 3.3. Economic processes within real estate life cycle and their cost control.	2	lecture
4	Identification of our objects of life cycle analysis.	2	lecture
5	Cost engineering, construction cost planning. 5.1. Problems and improvements of cost and price estimation in construction. 5.2. Building Information Modeling (BIM) in life cycle analysis. 5.3. 3D visualization of object and its structural elements. 5.4. Construction-Operation Building information exchange (COBie) in life cycle analysis.	2	lecture
6	Cost engineering case study.	2	lecture
7	Real estate maintenance analysis. 7.1. Imperatives of efficient Building Maintenance Management (BMM). 7.2. Technical and economic evaluation of building condition. 7.3. Real estate market price evaluation. 7.4. End of life analysis.	2	lecture
8	Real estate operation analysis. 8.1. Real estate operation. Facility Management (FM). 8.2 Real estate Assets Management (AM).	2	lecture
9	Real estate value engineering case.	2	lecture



10	Life cycle analysis of several types of real estate objects. 10.1. Public real assets and portfolio analysis. Facility Condition Indexes (FCI). 10.2. Enterprise fixed assets. Analysis of critical assets. 10.3. Cost of homeownership. Sustainability of housing.	2	lecture
11	Case study of public, industrial and housing objects.	2	lecture
12	Introduction to the costs estimation based on mathematical modelling 12.1. Modelling risk of failures during building life-cycles 12.2. Data acquisition and modelling the energy consumption of various case studies 12.3. Data acquisition and modelling the effectiveness of various energy sources	2	lecture
13	Ecological impact of the building within the life-cycle 13.1. Estimation of the carbon footprint of materials 13.2. Estimation of the carbon footprint during the building life-cycle 13.3. Estimation of the water footprint during the building life-cycle 13.4. Smart systems implementation for the various footprints control and management	2	lecture
14	Estimation of costs within the life-cycle of using housing objects	2	lecture
15	Referring the life-cycle analyses of the case studies	2	lecture

4. Prerequisites

List of prerequisites relating to knowledge, skills and other competences for course participants.

Master degree in engineering or management

5. Learning outcomes

List of learning outcomes at level 8 of the Polish Qualifications Framework assigned to the course (mark the learning outcomes in the last column).

Symbol	Learning outcome	
	<i>KNOWLEDGE. Doctoral student knows and understands:</i>	
SzD_W3	the main trends in the development of the scientific or artistic disciplines covered in the curricula;	<input checked="" type="checkbox"/>
SzD_W4	research methodology;	<input checked="" type="checkbox"/>
SzD_W5	the rules for the dissemination of scientific results, including in open access mode;	<input type="checkbox"/>
SzD_W6	the fundamental dilemmas of modern civilization;	<input type="checkbox"/>
SzD_W7	the legal and ethical conditions of scientific activity;	<input type="checkbox"/>



SzD_W8	the economic and other relevant conditions of scientific activity;	<input checked="" type="checkbox"/>
SzD_W9	basic principles of knowledge transfer to the economic and social spheres and commercialisation of results of scientific activity and know-how related to these results.	<input checked="" type="checkbox"/>
<i>SKILLS. Doctoral student is able to:</i>		
SzD_U2	use knowledge from different fields of science or art to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular: - define the purpose and subject of scientific research, formulate a research hypothesis, - develop research methods, techniques and tools, and use them creatively, - draw conclusions on the basis of scientific research; critically analyse and evaluate the results of scientific research, expertise and other creative work and their contribution to knowledge development; transfer the results of scientific activities to the economic and social spheres;	<input checked="" type="checkbox"/>
SzD_U3	communicate on specialised topics to the extent that they enable an active participation in the international scientific community;	<input type="checkbox"/>
SzD_U4	disseminate research results, including in popular forms;	<input checked="" type="checkbox"/>
SzD_U5	initiate debates and participate in a scientific discourse;	<input checked="" type="checkbox"/>
SzD_U6	be able to speak a foreign language at B2 level of the Common European Framework of Reference for Languages to a level that enables them to participate in the international scientific and professional environment;	<input checked="" type="checkbox"/>
SzD_U7	plan and implement an individual or collective research or creative activity, including in an international environment;	<input checked="" type="checkbox"/>
SzD_U8	independently plan and act for one's own development and inspire and organize the development of others;	<input type="checkbox"/>
SzD_U9	plan classes or groups of classes and implement them using modern methods and tools.	<input checked="" type="checkbox"/>
<i>SOCIAL COMPETENCES. Doctoral student is ready to:</i>		
SzD_K3	fulfilling the social obligations of researchers and creators, initiate public interest activities, thinking and acting in an entrepreneurial way;	<input checked="" type="checkbox"/>
SzD_K4	maintaining and developing the ethos of research and creative environments, including: - carrying out scientific activities in an independent manner, - respecting the principle of public ownership of research results, taking into account the principles of intellectual property protection.	<input type="checkbox"/>

6. Evaluation

Short description of the method(s) used to evaluate the learning outcomes assigned to the course, e.g., exam, test, report, presentation, etc.

Mid-terms Presentations.

Test.

7. Teaching methods



Short description of the teaching methods used during the course, e.g., multimedia presentation, discussion, literature studies, developing written documents, own work, etc.

Multimedia presentations.

Own work.

Written documents of the topic dedicated to the topic.

8. Literature

List of primary and secondary literature used to prepare the course and including additional knowledge for participants, e.g., books, textbooks, research papers, standards, web pages, etc.

International Standards

ISO 14040:2006. Environmental management. Life cycle assessment. Principles and framework.

ISO 15686-4:2014. Building Construction Service Life Planning. Part 4: Service Life Planning using Building Information Modelling.

ISO 55000:2014. Asset management. Overview, principles and terminology.

ISO 41001:2018. Facility management. Management systems. Requirements with guidance for use.

Handbooks

Flanagan, R. and Jewell, C. (2005). Whole life appraisal for construction / Oxford: Blackwell Publishing.

C. Eastman, C.M. Eastman, P. Teicholz, R. Sacks (2011). BIM handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors. John. Wiley & Sons.

BIM Guide For Facility Management (2011). GSA. - 82 p.

What is COBie? <https://www.thenbs.com/knowledge/what-is-cobie#article>

Good practice in housing management: a review of the literature (2001) / Edinburgh: The Scottish Executive General Research Unit.

Dell'Isola, A. J. and Kirk, S. J. (2003). Life cycle costing for facilities: economic analysis for owners and professionals in planning, programming, and real estate development: designing, specifying, and construction, maintenance, operations, and procurement / Reed Construction Data.

Johnson, P. Dale (2002). Principles of controlled maintenance management / Lilburn, GA: The Fairmont Press.

An owners guide to project delivery methods (2012). – CMAA.

Integrated project delivery: a guide (2007). – AIA.

Ніколаєв В.П. (2012). Розвиток економічних відносин у будівництві: навчальний посібник. К.: КНУБА.

Будівельне інформаційне моделювання в управлінні вартістю життєвого циклу об'єктів: монографія (2018) / за ред. д-ра екон. наук В.П. Ніколаєва. – Івано-Франківськ.

Additional sources

R. Weron (2006). Modeling and forecasting electricity loads and prices: A statistical Approach, John Wiley & Sons Ltd, Chichester

Kristin Ballobin (2008). New standard contracts for integrated project delivery: an analysis of structure, risk, and insurance. Victor O. Schinnerer & Company, Inc.

Bowen B., Charette R.P., Marshall H.E. (1992). UNIFORMAT II: A Recommended Classification for Building Elements and Related Sitework / National Institute of Standards and Technology. - Special Publication 841, August.

Rink D. Swan. J. (1979). Product life cycle research: A Literature review // Journal of business Research, Vol 40.

Haworth D. (1975). The principles of life-cycle costing // Industrial forum. Vol. 6.

Gardner D. (1987). The product life cycle: A critical look at the literature // Review of marketing.



Harvey G. (1976). Life-cycle costing: a review of the technique // Management accounting, October.
S. S. Muthu, The Carbon Footprint Handbook, Apple Academic Press, ISBN-13 9781482262223, 2015

9. Other remarks

Additional remarks, comments, (e.g., language of the course)

The course will be taught in English.

Authors:

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