Wrocław University of Science and Technology
Doctoral School

COURSE CARD

1. Basic information

Course name in English:	Advanced measurement techniques	
Course name in Polish:	Nowoczesne techniki pomiarowe	
Number of hours:	30	
Type of course:	Elective course	
Form of course:	laboratory	
Code of course:		
Course leader:	Artur Iluk	
Faculty of the course leader:	W10 Faculty of Mechanical Engineering	
Email address of the course leader:	**artur.iluk@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	☒
	Automation, electronic, and electrical engineering	☒
	Information and communication technology	☒
	Biomedical engineering	☒
	Chemical engineering	☒
	Civil engineering and transport	☒
	Mechanical engineering	☒
	Environmental engineering, mining, and energy	☒
	Mathematics	☒
	Chemical sciences	☒
	Physical sciences	☒
	Management and quality studies	☒

2. Objectives

Expanding knowledge in the field of modern measurement techniques

Getting to know the practical applications of measurements using modern measuring techniques.

Presentation of limitations and barriers in the use of modern measurement techniques.

3. Content

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

No.	Topic	Number of hours	Form of classes
1	Introduction - introduction to modern measurement methods	2	laboratory
2	Photogrammetric measurements - TRITOP system	2	laboratory

3	Thermal imaging measurements - FLIR ThermoVision SC6000 HS camera	2	laboratory
4	Displacement measurements using a high-speed camera - Phantom V12 + TEMA system	2	laboratory
5	Optical deformation measurements - GOM Correlate system	2	laboratory
6	3D laser scanning - Leica P20 3D scanner	2	laboratory
7	Laser vibration measurement - POLITEC PSV-400 scanning vibrometer	2	laboratory
8	Strain gauge measurements of deformations and vibrations - LMS Scadas Recorder SCR05, VB7 vibrometer	2	laboratory
9	Defectoscopic measurements - crack depth measurement, ultrasonic flaw detector	2	laboratory
10	Experimental modal analysis - modal hammer and LMS Scadas Recorder SCR05	2	laboratory
11	6D motion measurements with accelerometers - XSENS system	2	laboratory
12	Spatial acoustic measurements - acoustic camera	2	laboratory
13			Select form
14			Select form
15			Select form

4. Prerequisites

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

1.Basic knowledge of measurement techniques

2.Basic knowledge of metrology

3. Basic knowledge of the laws of physics and technical mechanics

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	
	KNOWLEDGE. Doctoral student knows and understands:	
SzD_W3	the main trends in the development of the scientific or artistic disciplines covered in the curricula;	☐
SzD_W4	research methodology;	☒
SzD_W5	the rules for the dissemination of scientific results, including in open access mode;	☐
SzD_W6	the fundamental dilemmas of modern civilization;	☐
SzD_W7	the legal and ethical conditions of scientific activity;	☐

SzD_W8	the economic and other relevant conditions of scientific activity;	☐
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.	☐
	SKILLS. Doctoral student is able to:	
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;	☐
SzD_U3	communicate on specialised topics to the extent that they enable an active participation in the international scientific community;	☒
SzD_U4	disseminate research results, including in popular forms;	☐
SzD_U5	initiate debates and participate in a scientific discourse;	☐
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;	☐
SzD_U7	plan and implement an individual or collective research or creative activity, including in an international environment;	☒
SzD_U8	independently plan and act for one's own development and inspire and organize the development of others;	☐
SzD_U9	plan classes or groups of classes and implement them using modern methods and tools.	☒
	SOCIAL COMPETENCES. Doctoral student is ready to:	
SzD_K3	fulfilling the social obligations of researchers and creators, initiate public interest activities, thinking and acting in an entrepreneurial way;	☒
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.	☐

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.

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.

Presentation of the possibilities of measuring equipment.

Demonstration of use.

Possibility of self-measurement by students.

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.

Pauly, M., Mitra, N. J., Giesen, J., Gross, M. H., & Guibas, L. J. (2005). Example-based 3D scan completion. In *Symposium on Geometry Processing* (No. CONF, pp. 23-32).

Cahill, D. G. (1990). Thermal conductivity measurement from 30 to 750 K: the 3ω method. *Review of scientific instruments*, *61*(2), 802-808.

Działak, P., Ptak, M., Karliński, J., & Iluk, A. (2014). Injury biomechanics of a mining machine operator. In *2014 IRCOBI Conference Proceedings—International Research Council on the Biomechanics of Injury* (pp. 495-505).

9. Other remarks

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