Wrocław University of Science and Technology
Doctoral School

COURSE CARD

1. Basic information

Course name in English:	Advanced methods in the theory of acoustical waves and fields	
Course name in Polish:	Zaawansowane metody teorii fal akustycznych i pola akustycznego	
Number of hours:	30	
Type of course:	Elective course	
Form of course:	lecture	
Code of course:	W12AEE-SD0004W / AEQ100294W	
Course leader:	Professor Andrzej Dobrucki	
Faculty of the course leader:	W12 Faculty of Electronics, Photonics and Microsystems	
Email address of the course leader:	andrzej.dobrucki@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

C1 Acquisition of advanced knowledge, including application aspects, in the field of acoustic waves in gases, liquids and solids as well as sound source properties

3. Content

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

No.	Topic	Number of hours	Form of classes
1	Derivation of the wave equation in gas and liquid media	1	lecture
2	Parameters of the acoustic wave: sound speed, damping factor, B / A parameter. Intensity and level of sound intensity	2	lecture
3	Linear acoustic waves in lossy and dispersive media	2	lecture

4	Non-linear acoustic waves in lossy and lossless media. Burgers' equation	2	lecture
5	Non-linear acoustic waves in dispersive media. Korteweg-de Vries equation. Solitons	2	lecture
6	The KZK equation. Parametric antennas	2	lecture
7	Point source and acoustic dipole. Acoustic antennas	2	lecture
8	Sources with spherical symmetry. Spherical harmonics. Radiation impedance	2	lecture
9	Sources with cylindrical symmetry	2	lecture
10	Integral formulas of Kirchhoff and Rayleigh. Radiation of the piston in an infinite baffle	2	lecture
11	The boundary integral method as a tool for calculating acoustic fields of sound sources based on Kirchhoff's integral formula	2	lecture
12	Derivation of wave equations in solids	2	lecture
13	Types of waves in a three-dimensional continuum of solids	2	lecture
14	Geometric simplifications of wave propagation in solids. Waves in rods, beams and plates	2	lecture
15	Transition of waves in solids across the boundaries of the media. Rayleigh surface waves and plate Lamb waves	3	lecture

4. Prerequisites

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

None

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.

Oral colloquium at the end of the course

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 presentation, discussion

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.

Primary literature:
[1] Lecture

[2] E. Skudrzyk – The foundation of acoustics, Springer 1971

[3] L. Beranek, T. Mellow – Acoustics: Sound Fields and Transducers, Academic Press 2012

[4] J.L. Rose - Ultrasonic waves in solid media, Academic Press 2004

Secondary literature:
[1] M. Bruneau, T. Scelo, Fundamentals of Acoustics, ISTE 2006

9. Other remarks

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

I have not given prerequisites, but students should have an advanced knowledge of ordinary and partial differential equations