Wrocław University of Science and Technology
Doctoral School

COURSE CARD

1. Basic information

Course name in English:	Fatigue and Fracture of Materials and Structures	
Course name in Polish:	Zmęczenie i pękania materiałów i konstrukcji	
Number of hours:	30	
Type of course:	elective/wybieralne	
Form of course:	lecture	
Code of course:		
Course leader:	Associate professor, Grzegorz LESIUK	
Faculty of the course leader:	W10 Faculty of Mechanical Engineering	
Email address of the course leader:	grzegorz.lesiuk@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, electrical engineering and space technologies	☐
	Information and communication technology	☐
	Biomedical engineering	☒
	Chemical engineering	☒
	Civil engineering, geodesy and transport	☒
	Materials engineering	☒
	Mechanical engineering	☒
	Environmental engineering, mining, and energy	☒
	Mathematics	☒
	Chemical sciences	☒
	Physical sciences	☒
	Management and quality studies	☐

2. Objectives

C1. Learning the basics of fracture and fatigue mechanics
C2. Gaining the ability to analyze the process of fatigue crack propagation.
C3. To acquire skills related to the methods and methodology of conducting scientific research.
C4. To acquire the ability to prepare the presentation of scientific work results.
C5. Acquiring skills of conducting calculation analyses and elaborating laboratory results in the field of fracture mechanics.
C6. Acquiring skills of scientific cooperation in a team analyzing fatigue damage.
C7. Acquisition of basic knowledge in the development of scientific expertises

3. Content

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

No.	Topic	Number of hours	Form of classes
1	Determination of fracture toughness for engineering materials - linear fracture mechanics	2	lecture
2	Calculations in the range of linear elastic fracture mechanics	2	lecture
3	Energy methods - determination of J integral and its critical value	2	lecture
4	Calculation and analysis including plasticity ahead of a crack tip	2	lecture
5	Fatigue of materials - basic characteristics in a uniaxial loading condition	2	lecture
6	Fatigue Crack growth rate and fatigue life prediction – experimental approach.	2	lecture
7	Scientific cooperation. Lecture and group discussion.	2	lecture
8	Fatigue crack growth rate and fatigue life prediction - analytical and numerical calculations	4	lecture
9	Mixed-mode fatigue crack growth. Predicting of fatigue crack paths and fatigue lifetime estimation	4	lecture
10	Multiaxial fatigue - an overview of existing solutions for proportional and non-proportional loads	2	lecture
11	Case study - analysis of fatigue crack growth in structural components and damage analysis - example of expertise elaboration - description of fracture surface	4	lecture
12	Review and colloquium	2	lecture

4. Prerequisites

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

1.Basic knowledge of material strength
2.Basic knowledge of experimental 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.

Various forms of presentations / writing test

7. Teaching methods

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

Lecture, Presentation, Discussion, Self-work

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.

1. Anderson T.L. Fracture Mechanics. Fundamentals and Applications, Fourth Edition. — CRC Press, 2017.

2. Gdoutos, E. E. (2020). Fracture mechanics: an introduction (Vol. 263). Springer Nature.

3. Farahmand, B., Bockrath, G., & Glassco, J. (2012). Fatigue and fracture mechanics of high risk parts: application of LEFM & FMDM theory. Springer Science & Business Media.

4. Saxena, A. (2019). Advanced Fracture Mechanics and Structural Integrity. CRC Press.

5. BROCKS, Wolfgang. Plasticity and Fracture. Springer International Publishing, 2018.

6. Avellar, L., & Mac Donald, K. (2019). Mechanics of Materials and Fracture for High School Students. In Fracture, Fatigue, Failure and Damage Evolution, Volume 6 (pp. 111-114). Springer, Cham.

7. Lesiuk, G., Correia, J.A.F.O., Krechkovska, H.V., Pekalski, G., Jesus, A.M.P. de, Student, O., Degradation Theory of Long Term Operated Materials and Structures, Springer, 2020

8. Kinloch, A. J. (Ed.). (2013). Fracture behaviour of polymers. Springer Science & Business Media

9. Other remarks

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