



## 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	<input checked="" type="checkbox"/>
	Automation, electronic, electrical engineering and space technologies	<input type="checkbox"/>
	Information and communication technology	<input type="checkbox"/>
	Biomedical engineering	<input checked="" type="checkbox"/>
	Chemical engineering	<input checked="" type="checkbox"/>
	Civil engineering, geodesy and transport	<input checked="" type="checkbox"/>
	Materials engineering	<input checked="" type="checkbox"/>
	Mechanical engineering	<input checked="" type="checkbox"/>
	Environmental engineering, mining, and energy	<input checked="" type="checkbox"/>
	Mathematics	<input checked="" type="checkbox"/>
	Chemical sciences	<input checked="" type="checkbox"/>
	Physical sciences	<input checked="" type="checkbox"/>
	Management and quality studies	<input type="checkbox"/>

### 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.

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|---|
| 1. Basic knowledge of material strength<br>2. Basic knowledge of experimental mechanics |
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#### 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 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 checked="" type="checkbox"/>
SzD_W6	the fundamental dilemmas of modern civilization;	<input checked="" 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 checked="" 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 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 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 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 checked="" 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.*

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)*