Bialystok University of Technology

Doctoral School

COURSE DESCRIPTION CARD

Course name	Numerical Methods and Machine Learning in Material Processing I				
Course type	Optional	**Course code**	SDPB0134	**ECTS credits**	2
Forms and number of hours	Lecture: 20 h	**Scientific discipline**	Mechanical Engineering		
Course objectives	The objective of the course is to equip students with the skills to integrate advanced finite element methods (FEM), computational fluid dynamics (CFD), and machine learning (ML) techniques for modeling, simulating, and optimizing material processing technologies, with a focus on enhancing accuracy and efficiency in industrial and research applications.				
Course content	This course combines advanced numerical FEM methods and machine learning (ML) techniques to model, simulate, and optimize material processing technologies. Students will explore finite element methods (FEM), computational fluid dynamics (CFD), and multiscale modeling approaches in the context of material processing, such as additive manufacturing and composite material fabrication. Additionally, the course integrates machine learning algorithms for data-driven predictions, process optimization, and defect detection. Emphasis is placed on coupling traditional numerical techniques with ML to enhance efficiency, accuracy, and material processing applications. Practical examples and hands-on projects will provide students with tools to solve real-world challenges in industrial and research settings.				
Teaching methods	The multimedia presentation, information lecture, project preparation				
Assessment method	Exam and project preparation				
Symbol of learning outcome	**Learning outcomes**		**Reference to the learning outcomes for the field of study for the 8th level of Polish Qualification Framework (PRK)**		**Methods of assessing the learning outcomes**
LO1	The PhD student will use FEM and CFD to model and simulate material processing.		SD_W1, SD_W2		Passing the lecture and project

LO2	The PhD student will apply ML algorithms for predictions, optimization, and defect detection.	SD_U1	Passing the lecture and project
LO3	The PhD student will integrate numerical methods and ML to improve accuracy and efficiency.	SD_U1	Passing the lecture and project

Student workload (in hours)	
Lecture, project	0 / 20 / 0 / 0 / 0
Consultations	5
The unassisted student work	15
Implementation of project tasks and preparation for and participation in exams/tests	30
Total	70
ECTS credits	3

Basic references	1. Versteeg, H. K., & Malalasekera, W. (2007). An Introduction to Computational Fluid Dynamics: The Finite Volume Method (2nd ed.). Pearson Education. ISBN: 978-0131274983. 2. Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning. MIT Press. ISBN: 978-0262035613. 3. Raschka, S., & Mirjalili, V. (2019). *Python Machine Learning* (3rd ed.). Packt Publishing. ISBN: 978-1789955750.
Supplementary references	1. Reddy, J. N. (2019). An Introduction to the Finite Element Method (4th ed.). McGraw-Hill Education. ISBN: 978-1259861901.
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