COURSE SPECIFICATION

Course code	full-time programme:	**M#2-S1-ME-205**
	part-time programme:	
Course title in Polish	**Druk 3D i Skanowanie 3D**	
Course title in English	**3D Printing and 3D Scanning**	
Valid from (academic year)	**2024/2025**	

GENERAL INFORMATION

Programme of study	**MECHANICAL ENGINEERING**
Level of qualification	**first-cycle**
Type of education	**academic**
Mode of study	**full-time programme**
Specialism	**all**
Department responsible	**Department of Metrology and Modern Manufacturing**
Course leader	**dr hab. inż. Tomasz Kozior, prof. PŚk**
Approved by	**dr hab. Jakub Takosoglu, prof. PŚk, Dean of the Faculty of Mechatronics and Mechanical Engineering**

COURSE OVERVIEW

Course type		**programme-specific**
Course status		**compulsory**
Language of instruction		**English**
Semester of delivery	full-time programme	**Semester II**
	part-time programme	
Pre-requisites		
Examination required (YES/NO)		**NO**
ECTS value		**3**

Mode of instruction		**lecture**	**class**	**laboratory**	**project**	**seminar**
No. of hours per semester	full-time programme	**15**		**30**		
	part-time programme					

LEARNING OUTCOMES

Category of outcome	Outcome code	Course learning outcomes	Corresponding programme outcome code
Knowledge	W01	Has structured advanced knowledge in the field of computer science, engineering graphics and modern information technologies supporting the solution of various types of engineering issues such as processing digital files related to mechanics and machine construction, design, construction and prototyping using 3D printing technology and reverse engineering.	**MiBM1_W03**
	W02	Has in-depth knowledge of the nomenclature, construction, principles of operation of 3D printers and 3D scanners, and determining the basic parameters of their work.	**MiBM1_W06**
	W03	He knows, at an advanced level, modern additive manufacturing techniques for machine parts, also has detailed knowledge of the construction of various types of systems for processing and shaping materials (using 3D printing technology) and advanced knowledge allowing to design the appropriate variant of the device, depending on manufacturing techniques. Knows advanced 3D scanning methods.	**MiBM1_W07**
	W04	Has systematically expanded knowledge of the properties of structure construction and the use of engineering materials allowing for the proper selection of materials in the area of machine construction in order to use it to build models using 3D printing technology and to enable the 3D scanning process.	**MiBM1_W08**
	W05	Knows at an advanced level methods enabling the design of a technological process for the production process using 3D printing technology. Knows at an advanced level basic measurement methods, with particular emphasis on methods used in the selected specialty - in the area of 3D printing and 3D scanning. Has knowledge related to selected issues in the field of design - prototyping, broadly understood design, machine construction, technology of manufacturing basic elements of 3D printers and 3D scanners, assessment of operational properties and wear, diagnosis of technical condition, repair technology and safe use, knows and understands the basic processes occurring in the life cycle of devices, facilities and technical systems.	**MiBM1_W11**
	W06	Has the knowledge necessary to organize work in accordance with occupational health and safety, environmental protection and ergonomics regulations, focused on the operation of 3D printers and 3D scanners.	**MiBM1_W19**
Skills	U01	Is able to consciously use computer software in the area of mechanics and machine construction in the field of prototyping (3D printing), reverse engineering (3D scanning), manufacturing techniques, presentation of work results such as simulations of 3D printing strategies.	**MiBM1_U02**

	U02	Is able to prepare documentation regarding the implementation of an engineering task using specialized terminology in the field of mechanics and machine construction, prepare a text containing a discussion of the results of this task, taking into account various possible aspects of the device/detail design, using various engineering tools. Is able to analyze and synthesize the obtained results in terms of the developed 3D printing technology and technological parameters of the manufacturing process.	**MiBM1_U04**
	U03	Is able to design a simple technological process of 3D printing in the area of mechanics and machine construction and select appropriate machines and devices for this purpose. Is able to design the 3D scanning process and select appropriate machines and devices and their parameters for this purpose.	**MiBM1_U08**
	U04	Is able to select appropriate engineering materials, to ensure correct operation of the machine in the production area using 3D printing and reverse engineering.	**MiBM1_U14**
Competence	K01	Is ready to critically evaluate his knowledge and the need to obtain new information both from the literature and from experts in the field of mechanics and machine construction in the aspect of modern 3D printing and 3D scanning technologies.	**MiBM1_K01**
	K02	Is aware of the importance and understanding of non-technical aspects and effects of engineering activities in the area of prototyping, including its impact on the safety of other people and the impact on the environment and the responsibilities related to these issues.	**MiBM1_K02**

COURSE CONTENT

Type of instruction lecture	Topics covered
lecture	Introduction to the issues of 3D printing technology and 3D scanning for the field of Mechanical Engineering. Characteristics of computer programs for 3D scanning and processing point clouds. Discussion of construction of machines implementing layered production technologies and reverse engineering. Description of the implementation of the production process using 3D printing technology and 3D scanning. Introduction to working with digital files used in the 3D printing process and 3D scanning. Conversion to CAD files. Modeling and design using 3D scanning. Printing process parameters and its influence on the products quality. Description of technology, application and properties of materials based on selected 3D printing methods. Aspects of standardization in the additive manufacturing process.
laboratory	Construction of 3D printers. Working with digital files used in 3D printing. Development of laboratory exercises taking into account the impact of technological parameters on the quality of manufactured models. Construction and principle of operation of the scanner used, software interface. 3D scanning of objects of various shapes. Processing of the obtained point cloud. Creating a surface model.

ASSESSMENT METHODS

Outcome code	Methods of assessment *(Mark with an X where applicable)*					
	Oral examination	Written examination	Test	Project	Report	Other
W01			X		X	
W02			X		X	
W03			X		X	
W04			X		X	
W05			X		X	
W06			X		X	
U01					X	
U02					X	
U03					X	
U04					X	
K01					X	
K02					X	

ASSESSMENT TYPE AND CRITERIA

Mode of instruction	Assessment type	Assessment criteria
lecture	non-examination assessment	Positive completion of the final colloquium. Obtaining at least 50% of points.
laboratory	non-examination assessment	Passing all reports with at least 50% each.

OVERALL STUDENT WORKLOAD

ECTS weighting												
No.	Activity type	Student workload										Unit
		full-time programme					part-time programme					
		L	C	Lb	P	S	L	C	Lb	P	S	
1.	Scheduled contact hours	15		30								h
2.	Other contact hours (office hours, examination)	2		2								h
3.	**Total number of contact hours**	**49**										h
4.	**Number of ECTS credits for contact hours**	**2**										ECTS
5.	**Number of independent study hours**	**26**										h
6.	**Number of ECTS credits for independent study hours**	**1**										ECTS
7.	**Number of practical hours**	**50**										h
8.	**Number of ECTS credits for practical hours**	**2**										ECTS

9.	**Total study time**	**75**		h
10.	**ECTS credits for the course** *1 ECTS credit = 25-30 hours of study time*	**3**		ECTS

READING LIST

1. Kozior T., Bochnia J.: Fundamentals of rapid prototyping, 3D printing, FDM/FFF technology, publisher – Kielce University of Technology, Kielce 2024.
2. Bochnia J.: Wybrane właściwości fizyczne materiałów kształtowanych technologiami przyrostowymi, publisher – Kielce University of Technology, Kielce 2018.
3. Budzik G., Siemiński P.: Techniki przyrostowe. Druk 3D. Drukarki 3D, Publisher – Warsaw University of Technology, Warsaw 2015.
4. Budzik G., Woźniak J., Przeszłowski Ł.: Druk 3D jako element przemysłu przyszłości. Analiza rynku i tendencje rozwoju, Publisher - Rzeszów University of Technology, Rzeszów 2022.
5. Chua., Chee Kai.: 3D printing and additive manufacturing : principles and applications, the 5th edition of rapid prototyping: principles and application, World Scientific, 2017.
6. Makerbot Sketch - User Manual, available online 11.06.2024.
7. Bochnia J.: Zastosowanie skanowania 3D w inżynierii odwrotnej, Mechanik, 3/2019.
8. Adamczak S., Błasiak S., Bochnia J., Pomiary wielkości geometrycznych modeli kształtowanych przyrostowo z zastosowaniem skanera 3D, Mechanik, 87, 2014, pp. 17-25.
9. Karbowski K.: Podstawy rekonstrukcji elementów maszyn i innych obiektów w procesach wytwarzania. Cracow University of Technology, monography 367, 2008.
10. Kantaros A., Ganetsos T., Petrescu F.: Three-Dimensional Printing and 3D Scanning: Emerging Technologies Exhibiting High Potential in the Field of Cultural Heritage, Applied Science, 2023, 13, 4777. https://doi.org/10.3390/app13084777.
11. Silva R., Silva B., Fernandes C., Morouço P., Alves N., Veloso A.: A Review on 3D Scanners Studies for Producing Customized Orthoses, Sensors 2024, 24, 1373. https://doi.org/10.3390/s24051373
12. User Manual – 3D scanning Atos II and 3D EinScan SE.

Scientific Journals

1. Rapid Prototyping, Emerald, ISSN 1355-2546.
2. 3D Printing and Additive Manufacturing, Mary Ann Liebert, Inc, ISSN 2329-7662.
3. Virtual and Physical Prototyping, Taylor & Francis, ISSN 1745-2759.
4. Materials, MDPI, ISSN 1996-1944.
5. MM Science, ISSN 1803-1269.