COURSE SPECIFICATION

Course code	full-time programme:	**M#2-S1-ME-207B**
	part-time programme:	
Course title in Polish	**Podstawy nanotechnologii**	
Course title in English	**Fundamentals of Nanotechnology**	
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 Maintenance, Laser and Nanoscale Technologies**
Course leader	**dr hab. inż. Monika Madej, 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		**elective**
Language of instruction		**English**
Semester of delivery	full-time programme	**Semester II**
	part-time programme	
Pre-requisites		
Examination required (YES/NO)		**NO**
ECTS value		**2**

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

LEARNING OUTCOMES

Category of outcome	Outcome code	Course learning outcomes	Corresponding programme outcome code
Knowledge	W01	The student has knowledge of physics (including mechanics, thermodynamics and fluid mechanics) and chemistry.	MiBM1_W02
	W02	The student has knowledge in the field of mechatronics, electrical engineering, electronics, automation for formulating and solving simple technical problems	MiBM1_W04
	W03	The student has knowledge in the field of micro/nanotechnology: modern engineering materials, their research methods and application areas	MiBM1_W08 MiBM1_W10
	W04	The student has knowledge of surface engineering (including: modeling of the surface layer, assessment of the condition and durability of the surface and tribological tests).	MiBM1_W17
	W05	The student has the knowledge necessary to organize work in accordance with occupational health and safety regulations.	MiBM1_W19
Skills	U01	Student is able to use Polish and foreign-language literature, obtain knowledge from other sources and interpret it correctly.	MiBM1_U03
	U02	Student is able to organize a workstation, operate instruments, devices and machines in accordance with applicable safety rules	MiBM1_U08 MiBM1_U11
	U03	The student is able to select the appropriate material for the operational function, classify wear processes and ways of minimizing them.	MiBM1_U14
	U04	The student understands the need to comply with health and safety rules. Able to work in a group and act in a creative and enterprising manner. Is able to plan and organize the work of himself and his team in an effective and safe manner.	MiBM1_U17 MiBM1_U20
Competence	K01	The student is ready to critically evaluate his knowledge. Understands the need to obtain new information both from literature and from experts in the field of mechanics and machine construction.	MiBM1_K01
	K02	The student is aware of the consequences of engineering activities, its impact on the environment, and the related responsibility for decisions made.	MiBM1_K02
	K03	The student is aware of the need for personal development and understands the need to constantly supplement their knowledge of materials science in order to improve their professional qualifications.	MiBM1_K03

COURSE CONTENT

Type of instruction lecture	Topics covered
lecture	History of nanotechnology – breakthrough concepts, inventions, discoveries. Nanotechnology - classification of research and application areas. Examples of processes occurring in nature on the "nano" scale. Classification of nanomaterials: nanometals, nanopowders, ceramic nanosinters, nanofibers, nano-structured coatings and surface layers. Nanomaterials and functional composites with advanced physicochemical and functional properties - methods of preparation. Carbon nanostructures (graphene, nanotubes, fullerenes, nanofibers, nanobulbs, nanocorners) - properties, preparation and examples of applications in machine construction. Construction and principle of operation of devices used to produce surface nanolayers and coatings - deposition of atomic layers, ion implantation. Structure, principle of operation and imaging capabilities using scanning electron microscopy. Benefits and threats resulting from the use of nanotechnology in mechatronics and machine construction. Prospects for the development of nanotechnology (directions and limitations).
laboratory	Preparation of samples for technological processes. Selection of the type of nanolayers and nanocoatings and their deposition parameters depending on the operational function. Deposition of nanolayers using the atomic layer technique - ALD. Observations of morphology and analysis of chemical composition using scanning electron microscopy. Analysis of the geometric structure of the surface. Mechanical tests on the nanoscale: instrumental hardness, adhesion. Assessment of the impact of deposited coatings on tribological properties.

ASSESSMENT METHODS

Outcome code	Methods of assessment *(Mark with an X where applicable)*					
	Oral examination	Written examination	Test	Project	Report	Other
W01			x			
W02			x			
W03			x			
W04			x			
W05			x			
U01					x	
U02					x	
U03					x	
U04					x	
K01			x			
K02			x			
K03					x	

ASSESSMENT TYPE AND CRITERIA

Mode of instruction	Assessment type	Assessment criteria
lecture	non-examination assessment	The pass mark is a minimum of 50% for the final in-class test.
laboratory	non-examination assessment	The pass mark is a minimum of 50% for each in-class pre-lab test and each post-lab report.

OVERALL STUDENT WORKLOAD

ECTS weighting												
No.	Activity type	Student workload										Unit
		full-time programme					part-time programme					
1.	Scheduled contact hours	L	C	Lb	P	S	L	C	Lb	P	S	h
		15		15								
2.	Other contact hours (office hours, examination)	2		2								h
3.	**Total number of contact hours**	**34**										h
4.	**Number of ECTS credits for contact hours**	**1,4**										ECTS
5.	**Number of independent study hours**	**16**										h
6.	**Number of ECTS credits for independent study hours**	**0,6**										ECTS
7.	**Number of practical hours**	**25**										h
8.	**Number of ECTS credits for practical hours**	**1,0**										ECTS
9.	**Total study time**	**50**										h
10.	**ECTS credits for the course** *1 ECTS credit = 25-30 hours of study time*	**2**										ECTS

READING LIST

1. Sheeja D., Tay B.K., Leong K.W., Lee C.H.: Effect of film thickness on the stress and adhesion of diamond-like carbon coatings. Diamond and Related Materials 11, 1643-1647, 2002.
2. Small Wonders, Endless Frontiers: A Review of the National Nanotechnology Initiative, National Academies Press (US) 2002.
3. Bull S.J., Bhat D. G., Staia M.H.: Properties and performance of commercial TiCN coatings, Surface and Coatings Technology 163-164, 507-514, 2003.
4. Balzani V., Credi A., Venturi M.: Molecular devices and machines : concepts and perspectives for the nanoworld. Weinheim: Wiley-VCH, 2008.
5. Kubiński W.: Materiałoznawstwo. Tom 1. Podstawowe materiały stosowane w technice. Wyd. AGH, Kraków 2012.
6. Mądziel M., Nanotechnology as a future of road transport development. Autobusy, 17, 12, 2016.

7. Krzyńska A., Kaczorowski M.: Konstrukcyjne materiały metalowe, ceramiczne i kompozytowe. Oficyna Wydawnicza Politechniki Warszawskiej, Warszwa 2020.
8. Li H., Lv S., Fang Y.: Bio-inspired micro/nanostructures for flexible and stretchable electronics. Nano Research, 13(5): 1244–1252, 2020.
9. Kan C.W., Lam Y.L.: Future Trend in Wearable Electronics in the Textile Industry. Applied Science, 11, 1-17, 2021.