COURSE SPECIFICATION

Course code	full-time programme:	**M#2-S2-ME-PT-214**
	part-time programme:	
Course title in Polish	**Laserowa i plazmowa obróbka powierzchniowa**	
Course title in English	**Laser and Plasma Processes**	
Valid from (academic year)	**2024/2025**	

GENERAL INFORMATION

Programme of study	**MECHANICAL ENGINEERING**
Level of qualification	**second-cycle**
Type of education	**academic**
Mode of study	**full-time programme**
Specialism	**Design and Manufacturing**
Department responsible	**Department of Maintenance, Laser and Nanoscale Technologies**
Course leader	**dr inż. Hubert Danielewski**
Approved by	**dr hab. Jakub Takosoglu, prof. PŚk, Dean of the Faculty of Mechatronics and Mechanical Engineering**

COURSE OVERVIEW

Course type		**specialism-related**
Course status		**compulsory**
Language of instruction		**English**
Semester of delivery	full-time programme	**Semester II**
	part-time programme	**Semester II**
Pre-requisites		
Examination required (YES/NO)		**YES**
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	Has a structured and theoretically grounded knowledge of laser and plasma surface treatment and is familiar with the main development trends in these fields.	MiBM2_W03
	W02	Has detailed and theoretically supported knowledge related to the assessment of the performance and use of laser technology for surface layer modification and performance properties.	MiBM2_W07
	W03	He has a comprehensive knowledge of surface engineering, e.g. modelling of the surface layer, assessment of surface condition and durability, measurement of geometrical parameters of surfaces, tribological testing of surfaces after laser treatment.	MiBM2_W11
Skills	U01	Can apply knowledge to design laser and plasma surface treatment, material selection, process parameters.	MiBM2_U01
	U02	Be able to prepare documentation for the execution of an engineering task related to the planning of the laser and plasma surface treatment process.	MiBM2_U04
	U03	Can select methods and tools for laser and plasma surface treatment processes aimed at using the beam to selectively vapourise the surface.	MiBM2_U08
Competence	K01	He is aware of the importance and understanding to the non-technical aspects and effects of engineering activities, including its impact on the safety of others and the impact on the environment and the related responsibilities.	MiBM2_K02
	K02	Is ready to responsibly perform professional roles related to the field of study of mechanics and mechanical engineering, adhere to ethical principles and act to adhere to these principles taking into account the changing needs of society, cares about the achievements, ethos and traditions of the profession.	MiBM2_K05

COURSE CONTENT

Mode of instruction	Topics covered

lecture	Basic concepts of laser and plasma surface treatment, effects of coherent and coherent optical radiation and plasma jet to produce thermal phenomena in the material. Determination of emissivity and absorptivity of the material for different wavelength ranges of the laser beam, distribution of radiation intensity across the cross-section, shape and duration of pulses. Generation of laser radiation for different types of active medium including pulsed lasers. Interaction of a focused laser beam with the surface of materials: heating, melting, vaporisation, cold ablation. Creation of photo-thermal and photo-chemical phenomena. Basic parameters of laser and plasma surface treatment processes, use of different optics, shape and peak energy in the pulse. Effect of polarisation on the effect of the laser beam on the surface of different materials. Absorptivity of the laser beam when treating metallic materials. Methods to increase absorption. Laser surface heat treatment of metals - laser hardening and alloying using selective surface remelting. Laser surface processing: texturing, cleaning, marking and micro hollowing of surfaces. Additive laser surface processing using selective deposition of additive material through laser beam interactions. Using LMD and LWD methods to modify surface properties and regenerate surfaces.
laboratory	Selection of laser hardening parameters including hardness measurement. Surface alloying using selective laser beam remelting. Laser hollowing of holes and micro-holes in metallic and non-metallic materials. Influence of deposition parameters of the additive material on the shape of the deposition profile. Laser surface strengthening by surfacing using selective metal powder melting (LMD). Laser surface reconditioning using deep deposition of additive material in solid wire form (LWD). Incremental laser processing. Surface cleaning using burn-in, evaporation and cold ablation mechanisms. Selective surface texturing using pulsed lasers and scanning systems. Surface marking of various materials using laser beams and selective ablative material removal.

ASSESSMENT METHODS

Outcome code	Methods of assessment					
	Oral examination	Written examination	Test	Project	Report	Other
W01			X			
W02			X			
W03			X			
U01			X		X	
U02			X		X	
U03			X		X	
K01						X
K02						X

ASSESSMENT TYPE AND CRITERIA

Mode of instruction	Assessment type	Assessment criteria
lecture	non-examination assessment	Successful completion of the final colloquium. Obtaining at least 50% of the points.
laboratory	non-examination assessment	Successful completion of class reports and obtaining at least 50% of the points on the final colloquium.

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)	**4**		**2**								h
3.	**Total number of contact hours**	**36**										h
4.	**Number of ECTS credits for contact hours**	**1,4**										ECTS
5.	**Number of independent study hours**	**14**										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. J. Kusiński, Lasery ich zastosowanie w inżynierii materiałowej.
2. M. Sparkes, W.M. Steen, Handbook of Laser Technology and Applications, CRC Press 2021
3. P. Cavaliere, Laser cladding of metals, Springer 2021
4. J. Landers, Laser engineering, Wilford Press, 2016
5. C. Breck Hitz, J. Ewing, J. Hecht, Introduction to Laser Technology, Willey, 2012
6. G. Laufer, Introduction to Optics and Lasers in Engineering, Cambridge University Press 2005
7. S. Santhanakrishnan, N. B. Dahotre, ASM Handbook - Steel Heat Treating Fundamentals and
8. Processes, ASM International, 2013
9. Z. Szymański, Fizyka laserów
10. Z. Mucha, Modelowanie i badania eksperymentalne laserowego kształtowania materiałów konstrukcyjnych, WPŚ 2004