COURSE SPECIFICATION

Course code	full-time programme:	**M#2-S2-ME-PT-110**
	part-time programme:	
Course title in Polish	**Obróbka laserowa i plazmowa**	
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. Piotr Sęk**
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 I**
	part-time programme	**Semester I**
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	Has an in-depth and structured knowledge of physics, in particular the knowledge necessary to understand the physical phenomena occurring in laser and plasma devices.	MiBM2_W02
	W02	Has a detailed and in-depth knowledge of the machining of machine parts, including cavity techniques, methods of bonding materials taking into account laser technology.	MiBM2_W05
	W03	Has in-depth knowledge in the area of measurement of geometrical, mechanical, operational or strength parameters of components made by laser and plasma machining.	MiBM2_W08
Skills	U01	Able to use computer software to control the processes of laser and plasma equipment.	MiBM2_U02
	U02	Can analyse and synthesise the results obtained and prepare a text including a discussion of the results concerning the laser and plasma treatment process.	MiBM2_U04
	U03	Can design a technological process in the area of laser and plasma machining and select appropriate machines and equipment for this purpose.	MiBM2_U07
Competence	K01	Is aware of the need to independently supplement and extend knowledge in laser and plasma processing. Understands the need for and knows the opportunities for continuous improvement.	MiBM2_K01
	K02	He/she is ready to fulfil the professional roles related to the field of study Mechanics and Mechanical Engineering in a responsible manner. Adheres to the principles of professional ethics and takes action to uphold them.	MiBM2_K05

COURSE CONTENT

Mode of instruction	Topics covered
lecture	Basic concepts of laser and plasma technology, fundamentals of laser and plasma devices, properties of laser radiation and ionised plasma flux. Fundamentals of optics, including focusing and transport of the laser beam, Rayleigh length, beam modality. Safety principles of working with laser equipment including the effects of laser radiation on living organisms depending on the type of laser source used. Interaction of the focused laser beam with the metal surface: heating, melting and formation of channel phenomenon. Basic parameters of laser beam processes: power, speed, frequency, focus position, use of different optics. Description of conductive and deep (with vapour channel) laser welding. Methods of laser cutting of materials. Laser shaping of materials using gradient and swell mechanism. Surface laser power density - influence on laser processing. Oscillating beam laser welding. Conductive and deep laser welding as well as continuous and pulse laser welding. Laser welding with consumables. Laser welding of butt, fillet and lap joints. Laser free-forming of materials using gradient and swell mechanism, mechanically assisted freeforming. Process design for laser cutting

laboratory	Influence of processing parameters on the course and effect of laser cutting, cutting different contours. Laser ablative cutting with a scanning beam. Free and mechanically assisted laser forming. Selection of laser welding parameters for butt, fillet and lap joints. Laser pulse welding. Influence of shielding gas type and output on laser welding process and weld shape. Laser welding with consumables. Laser welding with beam splitting systems. Programming of linear decrease and power increase during laser welding. Laser welding of dissimilar joints. Laser brazing. Laser cutting using basic methods for different metal groups (carbon steel, stainless steel and aluminium). Selection of laser welding parameters for materials including the effect of individual parameters on weld shape. Shaping of metal using selective laser beam surface scanning, measurement of bending angle. Influence of current parameters and plasma cutting speed on the effect of side edge surface quality.

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)	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. W. M. Steen, J. Mazumder, Laser Material Processing, Springer 2010.
2. A. Klimper, Nowoczesne lasery i technologie laserowe w inżynierii spawalnictwa, WPŚ 2023
3. A. Klimper, Technologie laserowe w spawalnictwie, PŚ, 2011
4. S. Katayama, Handbook of laser welding, Woodhead Publishing 2013
5. K. Ferenc, Spawalnictwo, PWN, 2016
6. J. Pilarczyk. Poradnik Inżyniera – spawalnictwo, WNT, 2022
7. S. Katayama, Fundamentals and Details of Laser Welding, Springer 2020
8. Ch. Dawes, Laser welding, Elsevier Science & Technology, 1992
9. B. S. Yilbas, The Laser Cutting Process: Analysis and Applications, Elsevier, 2017
10. B. Hatcher, Laser cutting fundamentals, 2020