DESCRIPTION OF THE COURSE OF STUDY

Course code		**0533-2FIZ-C4-3PF**
Name of the course in	Polish	**III Pracownia Fizyczna**
	English	**Physical Laboratory III**

1. LOCATION OF THE COURSE OF STUDY WITHIN THE SYSTEM OF STUDIES

1.1. Field of study	physics
1.2. Mode of study	Full-time
1.3. Level of study	2nd degree
1.4. Profile of study	General academic
1.5. Person/s preparing the course description	Dr hab. Aldona Kubala-Kukuś, prof. UJK
1.6. Contact	aldona.kubala-kukus@ujk.edu.pl

2. GENERAL CHARACTERISTICS OF THE COURSE OF STUDY

2.1. Language of instruction	English
2.2. Prerequisites	Mathematical analysis, Fundamentals of physics, Statistical methods, Matter structure, Atomic physics, Fundamentals of nuclear physics

3. DETAILED CHARACTERISTICS OF THE COURSE OF STUDY

3.1. Form of classes		Laboratory classes
3.2. Place of classes		Courses in the UJK teaching rooms of the Faculty of Exact and Natural Science
3.3. Form of assessment		Credit with grade
3.4. Teaching methods		Laboratory methods (experiments)
3.5. Bibliography	**Required reading**	T. Hanc, *Pomiary optyczne*,WN-T, Warszawa, 1964. J.R. Meyer-Arendt, *Wstęp do optyki*, PWN, Warszawa,1977. Instrukcja Obsługi tomografu rentgenowskiego SkyScan 1172 w wersji polskiej i angielskiej. *Fizyczne metody diagnostyki medycznej i terapii*, pod red. Hrynkiewicz A.Z. i Rokita E., Wydawnictwo Naukowe PWN, wydanie dowolne. *Fizyczne metody badań w biologii, medycynie i ochronie środowiska*, pod red. Hrynkiewicz A.Z. i Rokita E., Wydawnictwo Naukowe PWN, wydanie dowolne. B. Dziunikowski, *Radiometryczne metody analizy chemicznej*. J. Braziewicz, E. Braziewicz, S. Chojnacki, M. Pajek, J. Semaniak, 1994: *Analiza rentgenowska próbek środowiskowych*. Monitoring Środowiska Regionu Świętokrzyskiego, nr 2, s. 39-46, Kieleckie Towarzystwo naukowe, Kielce. J. Araminowicz, K. Małuszyńska, M. Przytuła, *Laboratorium fizyki jądrowej*. N. A. Dyson, *Promieniowanie rentgenowskie w fizyce atomowej i jądrowej*, PWN Warszawa wydanie dowolne. H. Haken, H. Ch. Wolf, *Atomy i kwanty: wprowadzenie do współczesnej spektroskopii atomowe*, PWN Warszawa wydanie dowolne. B. Dziunikowski, *Energy dispersive x-ray fluorescence analysis*, PWN Warszawa 1989. R. Resnick, D. Halliday, *Podstawy fizyki* tom 5, PWN, Warszawa wydanie dowolne.
	Further reading	M. Żenkiewicz, *Adhezja i modyfikowanie warstwy wierzchniej tworzyw wielkocząsteczkowych*, WN-T, Warszawa 2000. B. Dubik, M. Zając, *Elementy interferometrii*, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław, 1998. P. Pawlus, *Topografia powierzchni (pomiar, analiza, oddziaływanie)*, Oficyna Wydawnicza Politechniki Rzeszowskiej, Rzeszów 2006. M. Przygocki, A. Włochowicz, *Fizyka polimerów. Wybrane zagadnienia*., PWN, Warszawa, 2001. J. Als-Nielsen, *Elements of modern X-ray physics*, Chichester: Wiley, 2011 G. Zschornack, *Handbook of X-ray data*, Springer, Berlin, 2007 B. Beckhoff (eds.) et al., *Handbook of practical X-ray fluorescence analysis*, Springer, Berlin, 2006.

4. OBJECTIVES, SYLLABUS CONTENT AND INTENDED LEARNING OUTCOMES

4.1. Course objectives (including form of classes)

Knowledge (lectures and laboratories)
C1 – familiarizing the student with the phenomena of general physics in practice
C2 – familiarizing the student with the experimental methods and the advanced apparatus of physics

4.2. Detailed syllabus (including form of classes)

Optionally, according to the schedule of classes, the student carries out some of the following program contents:

1. Interferometric study of diffusive transport of substances.
2. Investigation of the contact angle and surface energy.
3. Total Reflection X-Ray Fluorescence method. Elemental analysis using a PICOFOX spectrometer.
4. X-ray computed tomography. Imaging of samples using the SKYSCAN 1172 tomograph.
5. Analysis of the characteristic radiation of selected elements by X-ray fluorescence analysis with wavelength disspersive - AXIOS X-ray spectrometer.
6. X-ray photoelectron spectroscopy.
7. Studies on the phenomenon of scattering low-energy ions on atoms of a solid surface (ISS -Ion Scattering Spectroscopy).
8. Identification of residual gases in the vacuum chamber.
9. Observation of the characteristic radiation using a high resolution crystal spectrometer.
10. Examination of the surface topography of materials using the Secondary Electron Microscopy (SEM) and Scanning Auger Microscopy (SAM) techniques.
11. X-Ray Powder Diffraction (XRPD).
12. X-ray Reflectometry (XRR).

4.3. Education outcomes in the discipline

Code	A student, who passed the course	Relation to learning outcomes
within the scope of **KNOWLEDGE:**		
W01	has advanced knowledge of various fields of physics	FIZ2A_W01
W02	is able to independently provide and interpret the laws and physical principles of selected areas of physics	FIZ2A_W02
W03	knows the experimental and observational techniques used in physics	FIZ2A_W08
W04	knows the physical basics of experimental techniques and the principles of operation of advanced physical devices, e.g. X-ray spectrometers, tomograph, electron analyzer, interferometer	FIZ2A_W03 FIZ2A_W11 FIZ2A_W18
W05	has in-depth interdisciplinary knowledge, taking into account the latest achievements, resulting from the integration of knowledge from selected, studied disciplines	FIZ2A_W05
within the scope of **ABILITIES:**		
U01	is able to carry out a measurement using advanced physical devices, e.g. X-ray spectrometers, tomograph, electron analyzer, interferometer	FIZ2A_U01 FIZ2A_U03
U02	is able to present the results of the research in the form of a lecture / report containing a description and justification of the purpose of the work, the adopted methodology and their significance compared to other similar studies	FIZ2A_U07
within the scope of **SOCIAL COMPETENCE:**		
K01	Demonstrates the ability to work independently and in a team. Can define tasks and priorities for action.	FIZ2A_K02 FIZ2A_K03

4.4. Methods of assessment of the intended learning outcomes

Teaching outcomes *(code)*	Method of assessment (+/-)																				
	Oral answer			**Project**			**Self-study**			**Group work**			**Test**			**Effort in class**			**Report**		
	Form of classes			***Form of classes***			***Form of classes***			***Form of classes***			***Form of classes***			***Form of classes***			***Form of classes***		
	L	*C*	*P*	*L*	*C*	*P*	*L*	*C*	*P*	*L*	*C*	*P*	*L*	*C*	*P*	*L*	*C*	*P*	*L*	*C*	*P*
W01															***X***						
W02															***X***						
W03															***X***						
W04															***X***						
W05															***X***						
U01																					***X***
U02																					***X***
K01																		***X***			

4.5. Criteria of assessment of the intended learning outcomes

Form of classes	Grade	Criterion of assessment
Laboratory	**3**	at least 50% and not more than 60% of the total number of available points
	3,5	more than 60% and not more than 70% of the total number of available points
	4	more than 70% and not more than 80% of the total number of available points
	4,5	more than 80% and not more than 90% of the total number of available points
	5	more than 90% of the total number of available points

5. BALANCE OF ECTS CREDITS – STUDENT'S WORK INPUT

Category	Student's workload	
	Full-time studies	**Extramural studies**
NUMBER OF HOURS WITH THE DIRECT PARTICIPATION OF THE TEACHER /CONTACT HOURS/	***75***	
Participation in lectures		
Participation in laboratories/project	75	
Preparation for the exam		
Others		
INDEPENDENT WORK OF THE STUDENT/NON-CONTACT HOURS/	***50***	
Preparation for the lecture		
Preparation for the laboratories	20	
Preparation for the exam		
Gathering materials for the project		
Preparation of multimedia presentation		
*Others**	30	
TOTAL NUMBER OF HOURS	**125**	
ECTS credits for the course of study	**5**	

Accepted for execution *(date and signatures of the teachers running the course in the given academic year)*

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