

FACULTY of CHEMISTRY					
SUBJECT CARD					
Name of subject in Polish	Krystalografia i struktura ciał stałych				
Name of subject in English	Crystallography and structure of solids				
Main field of study (if applicable):	Biosciences				
Specialization (if applicable):	Medicinal Chemistry				
Profile:	academic				
Level and form of studies:	2nd level, full-time				
Kind of subject:	obligatory				
Subject code	W03BSS-SM2018W, W03BSS-SM2018C				
Group of courses	NO				
	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30	15			
Number of hours of total student workload (CNPS)	50	25			
Form of crediting (Examination / crediting with grade)	crediting with grade	crediting with grade			
For group of courses mark (X) final course					
Number of ECTS points	2	1			
including number of ECTS points for practical classes (P)		1			
including number of ECTS points corresponding to classes that require direct participation of lecturers and other academics (BU)	1,3	0.7			

*delete as not necessary

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. General knowledge of mathematics, physics and chemistry.

SUBJECT OBJECTIVES

C1 Knowledge of the structure, symmetry and diffraction of macro-, micro- and nanocrystals.

C2 Knowledge of directions of development of crystallography.

C3 Understanding data in crystallographic papers.

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

A person who has completed the course:

PEU_W01 has knowledge of the structure and symmetry of crystals.

PEU_W02 understands the international symbols and graphical representation of space groups and the international symbols of crystal classes.

PEU_W03 knows the relationships between a diffraction pattern and crystal structure.
 PEU_W04 has knowledge of directions of development of crystallography.
relating to skills:
 A person who has completed the course:
 PEU_U01 is able to study scientific literature on crystal structures and evaluate crystal data.
related to social competences:
 A person who has completed the course:
 PEU_K01 is able to take part in discussions on crystallographic structural studies.
 PEU_K02 understands the importance of crystallography in science and industry.

PROGRAMME CONTENT		
Lecture		Number of hours
Lec 1	The historical and current definitions of crystals and crystallography. The internal structure of crystals. A crystal lattice, row lines, lattice planes, Miller symbols, a unit cell and cell types. The mosaic structure of real crystals, dislocations.	2
Lec 2, Lec 3	The internal symmetry of crystals. Symmetry elements and operations. Relationships between the internal and external symmetry of crystals. Crystal systems vs symmetry.	4
Lec 4	Crystal systems and cell parameters. The conventional choice of unit cells. The Bravais unit cells.	2
Lec 5	Space groups: international symbols and graphical representations. An asymmetric unit cell.	2
Lec 6	Relationships between the symbol of a space group and the symbol of a point group (crystal class). The types of point groups.	2
Lec 7	Examples of crystal structures. Crystallographic databases.	2
Lec 8	X-rays: properties and sources. Synchrotron radiation: sources of the first, second, third and fourth generations and properties. Synchrotron crystallographic studies.	2
Lec 9, Lec 10	The directions and intensities of diffracted beams. Factors influencing the directions and intensities. The phase problem. Diffraction pattern vs internal structure and symmetry of crystals.	4
Lec 11	Neutronography and electronography vs roentgenography. Crystallographic information files (cif).	2
Lec 12, Lec 13	Nanocrystals. The quantitative and qualitative definition. The internal structure of nanocrystals vs macrocrystals. Defects. External appearance. Diffraction in nanocrystals vs diffraction in microcrystalline materials. The broadening and shifting of peaks in powder diffraction patterns. Apparent lattice parameters: determination and influencing factors. Properties. Synchrotron crystallographic studies of nanocrystals.	4
Lec 14	Quasi crystals: 1D, 2D and 3D-dimensional. Internal and external structure. Diffraction. Properties.	2
Lec 15	Crystallographic data in scientific papers.	2
Total hours		30

Classes		Number of hours
Cl 1	The preliminary class.	1
Cl 2	Lattice points, row lines, lattice planes.	1
Cl 3, Cl 4, Cl 5	Symmetry elements: an inversion center, a mirror plane, rotation axes, rotoinversion axes.	3
Cl 6, Cl 7	Screw axes and glide planes.	2
Cl 8	Bravais lattices.	1
Cl 9	Partial test I	1
Cl 10, Cl 11	Systematic absences.	2
Cl 12, Cl 13	Crystal classes: symbols and graphical representation.	2
Cl 14	Physical properties of crystals.	1
Cl 15	Partial test II	1
	Total hours	15

TEACHING TOOLS USED

N1. A multimedia presentation
 N2. Crystallographic models
 N3. A blackboard

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming during semester), P – concluding (at semester end)	Learning outcomes code	Way of evaluating learning outcomes achievement
F1 (lectures)	PEU_W01, PEU_W02, PEU_K01-K02	partial test I
F2 (lectures)	PEU_K01-K02, PEU_W03, PEU_W04	partial test II
F3 (classes)	PEU_W01 PEU_W02	partial test I
F4 (classes)	PEU_W03, PEU_U01	partial test II
$P1=(F1+F2)/2$ $P2=(F3+F4)/2$		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

- [1] P. Luger, Modern X-Ray Analysis on Single Crystals, de Gruyter, Berlin, 2014.
 [2] R. J. D. Tilley, Crystals and Crystal Structures, John Wiley & Sons Ltd, Chichester, 2006.

SECONDARY LITERATURE:

- [1] C. Giacovazzo, H. L. Monaco, G. Artioli, D. Viterbo, G. Ferraris, G. Gilli, G. Zanotti, M. Catti, Fundamentals of crystallography, C. Giacovazzo Ed., Oxford, 2011.
 [2] International Tables for Crystallography, Volume A, Springer, 2005; Willey 2016.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

team