(*faculty stamp*)

COURSE DESCRIPTION

1. Course title: CRYSTALLOGRAPHY	2. Course code
3. Validity of course description: 2015/2016	
4. Level of studies: 1st cycle of higher education	
5. Mode of studies: intramural studies	
6. Field of study: CHEMISTRY	(FACULTY SYMBOL) RCH
7. Profile of studies: general academic	
8. Programme:	
9. Semester: 4	
10. Faculty teaching the course: Department of Physical Chemistry and Technology of Polymers (RCh4)	
11. Course instructor: dr inż. Agata Blacha-Grzechnik	
12. Course classification: common courses	
13. Course status: compulsory	
14. Language of instruction: English	
15. Pre-requisite qualifications: Basic Mathematical and Chemical knowledge	
16. Course objectives: By participating in the lectures students gain the knowledge of crystal structure, crystal properties and their applications, methods of synthesis of crystals.	

17. Description of learning outcomes:

Nr	Learning outcomes description	Method of assessment	Teaching methods	Learning outcomes reference code
1.	The student knows the main definitions and crystallographic lows. The student has a basic knowledge of crystal structure. The student can designate symbols of directions and Miller indices of faces.	colloquium	lecture	K_W01 (++) K_W11 (++) K_U02 (+)
2.	The student has a basic knowledge of symmetry of crystals, point groups and space groups.	colloquium	lecture	K_W01 (++) K_W11 (++) K_U02 (+)
3.	The student has a basic knowledge of diffraction of X-rays by crystal lattice.	colloquium	lecture	K_W01 (++) K_W06 (+) K_W11 (++)
4.	The student has a basic knowledge of types of bonding in crystals.	colloquium	lecture	K_W01 (++) K_W11 (++) K_U02 (+)
5.	The student has a basic knowledge of crystal defects.	colloquium	lecture	K_W01 (++) K_W11 (++)
6.	The student has a basic knowledge of physical properties of crystals defects and their applications.	colloquium	lecture	K_W01 (++) K_W11 (++) K_U03 (+)
7.	The student knows the main methods of synthesis of crystals.	colloquium	lecture	K_W01 (++) K_W11 (++)

18. Teaching modes and hours

Lecture / BA /MA Seminar / Class / Project / Laboratory

Sem 4 - Lecture 30 h.

19. Syllabus description:

CRYSTAL STRUCTURE

Geometrical crystallography – space lattice of crystals

Definitions of crystal. The mine terms: space lattice (net), unit cell, nodes, directions in the crystal lattice, lattice plane. Coordinates of the point in the space lattice, symbol of direction in the space lattice, Miller indices for lattice plane. Crystal systems. Bravais lattice. The mine crystallographic lows: the low of rational indices, the low of constant dihedral angles. Computation of the number of sites in the unit cell, volume of the unit cell, distance between lattice planes.

Symmetry of crystals

Symmetry operations: rotations, translations, reflections, inversions. Symmetry elements: fixed (reflection) point, rotation axis, mirror plane, inversion axis, glade planes, screw axis. Point groups. Space groups.

Describing of crystal structure

Data bases of crystal structures. Presentation of computer programs for drawing crystal structures.

Diffraction of X-Rays by crystals.

Diffraction by a periodic structure: Laue equations, Bragg's law. Experimental diffraction methods. Determination of crystal structure.

Close-packed structure of crystals

Hexagonal and cubic close-packed structures. Tetrahedral and octahedral interstitial site.

CRYSTALLOCHEMISTRY

Bonding in crystal structures: ionic bond, covalent bond, metallic bond, van der Waals bond (physical and structural properties). Stoichiometric classification of crystal structures.
Polymorphism, isotypism, solid solution, isomorphism

CRYSTALLOPHYSICS

Crystal defects

Types of imperfection: point defects, line defects (dislocations), planar defects, volume defects.

Physical properties of crystals and their applications

Cleavage. Hardness. Piezoelectricity i pyroelectrycity. Optical properties.

Industrial techniques to produce single crystals

Hydrothermal synthesis. Czochralski process. Bridgman technique. Sublimation. Solvent-based crystallization. Producing single crystals by polymorphic change.

20. Examination: The student has to pass the finale colloquium at least at 50%

21. Primary sources:

1. M. de Graef, M. E. McHenry, "Structure of Materials - An Introduction to Crystallography, Diffraction and Symmetry" Cambridge Univesity Press, Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, 2007
2. D. Schwarzenbach „Crystallography", John Wiley & Sons, Chichester, New York, Brisbane, Toronto, Singapore, 1996
3. Edited by Theo Hahn "International Tables For Crystallography - Vol A - Space group symmetry" The International Union of Crystallography, Springer, 2005
4. D. E. Sands „Introduction to Crystallography", Dover Publication, Ltc, Mineola, New York, 1975
5. Z.Trzaska Durski, H.Trzaska Durska, „Podstawy krystalografii", Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2003
6. Z.Trzaska Durski, H.Trzaska Durska, „Podstawy krystalografii strukturalnej i rentgenowskiej", PWN, Warszawa 1994

22. Secondary sources:

1. Z.Bojarski, H.Habla, M.Surowiec, „Materiały do nauki krystalografii", PWN, Warszawa 1986
2. Z.Bojarski, M.Gigla, K.Stróż, M.Surowiec, „Krystalografia. Podręcznik wspomagany komputerowo", PWN, Warszawa 1996
3. A.F.Wells, „Strukturalna chemia nieorganiczna, WNT, Warszawa 1993
4. Z.Bojarski, E.Łągiewska, „Rentgenowska analiza strukturalna", PWN, Warszawa 1988
5. M.Van Meerssche, J.Feneau-Dupont, „Krystalografia i chemia strukturalna", PWN, Warszawa 1984
6. A.Kelly, G.W.Groves, "Krystalografia i defekty kryształów", PWN, Warszawa 1980
7. J.P.Glusker, K.N.Trueblood, „Zarys rentgenografii kryształów", PWN, Warszawa 1977
8. T.Penkala, „Zarys krystalografii", PWN, Warszawa 1977
9. W.A.Harrison, „Teoria ciała stałego", PWN, Warszawa 1976
10. J.Dereń, J.Haber, R.Pampuch, „Chemia ciała stałego", PWN, Warszawa 1975
11. J.Chojnacki, „Elementy krystalografii chemicznej i fizycznej", PWN, Warszawa 1973
12. L.V.Azaroff, „Struktura i własności ciał stałych", WNT, Warszawa 1960

23. Total workload required to achieve learning outcomes

Semester 1:

Lp.	Teaching mode :	Contact hours / Student workload hours
1	Lecture	30/30
2	Classes	/
3	Laboratory	/
4	Project	/
5	BA/ MA Seminar	/
6	Other	/
	Total number of hours	30/30

24. Total hours: 60

25. Number of ECTS credits: 2

26. Number of ECTS credits allocated for contact hours: 1

27. Number of ECTS credits allocated for in-practice hours (laboratory classes, projects): 0

26. Comments:

Approved:

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(date, Instructor's signature) (*date , the Director of the Faculty Unit signature)*