(*faculty stamp*)

COURSE DESCRIPTION

1. Course title: PHYSICAL CHEMISTRY	**2. Course code**
3. Validity of course description: 2014/2015	
4. Level of studies: 1st cycle of higher education	
5. Mode of studies: Intramural studies	
6. Field of study: Industrial and engineering chemistry	(FACULTY SYMBOL)
7. Profile of studies: Academic	
8. Programme: n. a.	
9. Semester: Fourth	
10. Faculty teaching the course: Faculty of Chemistry, Department of Physical Chemistry and Technology of Polymers	
11. Course instructor: dr inż. Wojciech Domagała	
12. Course classification: Fundamental	
13. Course status: Compulsory	
14. Language of instruction: English	
15. Pre-requisite qualifications: Basic knowledge of chemistry, mathematics and physics	
16. Course objectives: Presentation of fundamental laws in physical chemistry, properties of different states of mater, thermodynamics, chemical equilibrium, chemical kinetics, phase equilibria, surface phenomena, catalysis, electrochemistry.	

17. Description of learning outcomes:

Nr		Method of assessment	Teaching methods	Learning outcomes reference code
1.	Knowledge about phase equilibria in single and multi-component, multiphase systems. Skills in interpretation of phase diagrams.	examination	lecture	K_W02 ++ K_W07 ++ K_U11 ++
2.	Knowledge of phenomena occurring in solutions and at phase boundaries, laws governing these and their practical significance in chemical reactions.	examination	lecture	K_W02 ++ K_W07 ++ K_U05 + K_U11 ++

3.	Knowledge of electrical conductivity of electrolyte solutions, electrolysis, electrode processes, chemical sources of energy.	examination	lecture	K_W02 ++ K_W07 ++ K_U05 +
4.	Knowledge about basic photochemical processes, their theories and applications, spectroscopic methods in the study of the properties of materials.	examination	lecture	K_W02 ++ K_W07 ++ K_W14 ++ K_U05 +
5.	Knowledge about the application of theories in the quantitative description of physicochemical processes and phenomena, and the calculation problems thereof.	test	problem solving class	K_W01 ++ K_W02 ++ K_U01 + K_U09 + K_U23 + K_U26 +
6.	The ability to plan experiments, investigate chemical processes, determine physical and chemical properties and interpret the results obtained, as well as to assess the hazards of handling chemical reagents and the risks of performing experiments. Awareness of proper waste management procedures, as well as proper application of laboratory health and safety rules.	test, reports	hands-on laboratory	K_W07 ++ K_U07 + K_U14 ++

18. Teaching modes and hours:

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

30h / - / - / 15h / - / 45h

19. Syllabus description:

LECTURE

- **Phase equilibria in multicomponent systems.**

  Phase. Phase diagrams. The stability of phases. Phase boundaries. The thermodynamic criterion of phase equilibrium. Phase transitions. The Clausius - Clapeyron equation. The dependence of phase stability on the conditions. The Ehrenfest classification of phase transitions. Independent components and degrees of freedom. Gibbs phase rule. Two-component systems. Vapour pressure diagrams. Temperature-composition diagrams. Liquid–liquid phase diagrams. Liquid-solid phase diagrams. Distillation. Zeotropic and azeotropic mixtures. Eutectics. Liquid crystals.

- **Electrochemistry**

  The conductivities of electrolyte solutions. Conductance and conductivity. Strong and weak electrolytes. Mobilities of ions. Drift speed. Mobility and conductivity. Transport numbers. Conductivities and ion-ion interactions. The thermodynamic properties of ions in solution. The electrode-solution interface. Ion activities. Electrochemical cells. Half-reactions and electrodes. The electromotive force (EMF). Standard potentials. The electrochemical series. The measurements of pH and pKa. Relation of EMF with thermodynamic functions. The rate of charge transfer at the electrode. Electroanalytical methods. Working galvanic cells.

- **The liquid state – selected topics**

  Surface tension. Curved surfaces. Adhesion and Cohesion. Capillary action. Simple mixtures. The thermodynamic description of mixtures. Partial molar quantities. The thermodynamics of mixing. The chemical potential of liquids. The properties of solutions. Colligative properties. Solvent and solute activity. Liquid mixtures.

- **The solid state – surface phenomena**

  The growth and structure of solid surfaces. Adsorption and absorption. Physisorption and chemisorption. Adsorption isotherms. Adsorption and catalysis.

PROBLEM SOLVING CLASSES

- **Chemical kinetics**

  Kinetic equation of the chemical reaction. Determining the rate constant and half-life. Calculating the composition of a reaction mixture at a given time. Determining the order of the reaction. The Arrhenius equation. Temperature dependence of the rate of a chemical reaction. Determining the activation energy or a reaction.

- **Phase equilibrium in multi-component systems**

  Raoult's law. Calculating the composition of two-phase binary mixtures. Henry's law. Solubility of gasses in liquids.

LABORATORY CLASSES

1. Simulation of kinetics of selected types of chemical reactions using computer software
2. Determination of the rate of ionic chemical reaction; the effect of the ionic strength of the solution
3. Determination of activity and half-life of a radioactive sample
4. Determination of the limiting value of the molar conductivity of a strong electrolyte
5. Potentiometric measurements of pH
6. Determination of selected thermodynamic functions based on measurements of the electromotive force
7. Determination of the dissociation constant of a weak acid using conductivity and pH measurements
8. Determination of the acid-base equilibrium constant in aqueous solutions

20. Examination:

Yes

21. Primary sources:

- Peter Atkins, Julio de Paula - "Atkins' Physical Chemistry" 9th edition. Oxford University Press 2009.
- Peter Atkins, Julio de Paula - "Atkins' Physical Chemistry" 7th edition. Oxford University Press 2002.
- R. A. Alberty, R. J. Silbey, Physical Chemistry, John Willey & Sons, Inc. 1992.

22. Secondary sources:

- M. Hillert – "Phase Equilibria, Phase Diagrams and Phase Transformations: Their Thermodynamic Basis" 2nd edition. Cambridge University Press 2008.
- H. A. J. Oonk, M. T. Calvet – "Equilibrium Between Phases of Matter: Phenomenology and Thermodynamics" Springer 2008.
- John O'M. Bockris, Amulya K.N. Reddy, John O'M Bockris – "Modern Electrochemistry 1: Ionics" 2nd edition. Plenum Press 1998.
- John O'M. Bockris, Amulya K.N. Reddy, Maria E. Gamboa-Aldeco – "Modern Electrochemistry 2A: Fundamentals of Electrodics" 2nd edition. Plenum Press 1998.
- John O'M. Bockris, Amulya K.N. Reddy – "Modern Electrochemistry 2B: Electrodics in Chemistry, Engineering, Biology and Environmental Science" 2nd edition. Plenum Press 1998.
- G. de With – "Liquid-state physical chemistry". Wiley VCH 2013.
- H. J. Butt, K. Graf, M. Kappl, Physics and Chemistry of Interfaces, Wiley-VCH, 2003.
- G. A. Somorjai, Y. Li – "Introduction to surface chemistry and catalysis" 2nd edition. John Wiley & Sons Inc. 2010.
- R. I. Masel – "Principles of adsorption and reaction on solid surfaces" John Wiley & Sons Inc. 1996.
- B. Murphy, C. Murphy, B. J. Hathaway – "A working method approach for introductory physical chemistry calculations. Numerical and graphical problem solving." The Royal Society of Chemistry 1997.
- M. Mortimer, P. Taylor – "Chemical Kinetics and Mechanism" Open University course - the Molecular World. The Open University Royal Society of Chemistry 2002.
- R. G. Mortimer – "Mathematics for physical chemistry" 4th edition. Academic Press Elsevier 2013.

23. Total workload required to achieve learning outcomes

No.	Teaching mode :	Contact hours / Student workload hours
1	Lecture	30/30
2	Classes	15/15
3	Laboratory	45/45
4	Project	n. a.
5	BA/ MA Seminar	n. a.
6	Other	15/15
	Total number of hours:	105/105

24. Total hours:

210

25. Number of ECTS credits: 6 (six)
26. Number of ECTS credits allocated for contact hours: 3 (three)
27. Number of ECTS credits allocated for in-practice hours (laboratory classes, projects): 2 (two)
26. Comments: None

Approved:

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