FACULTY OF CHEMISTRY

SUBJECT CARD

Name of subject in Polish	Podstawy chemii fizycznej (kurs w jęz. ang.)
Name of subject in English	Fundamentals of physical chemistry
Main field of study (if applicable):	Biotechnologia; Inżynieria chemiczna; Chemia i inżynieria materiałów; Technologia chemiczna.
Specialization (if applicable):	
Profile:	academic
Level and form of studies:	1st level full-time
Kind of subject:	obligatory
Subject code	
Group of courses	YES

	Lecture	Classes	~~Laboratory~~	~~Project~~	~~Seminar~~
Number of hours of organized classes in University (ZZU)	30	30			
Number of hours of total student workload (CNPS)	90	90			
Form of crediting	Examination	Examination			
For group of courses mark (X) final course	X				
Number of ECTS points	3	3			
including number of ECTS points for practical (P) classes		3			
including number of ECTS points for direct teacher-student contact (BU) classes	1,3	1,4			

***PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES**

1. Elemental mathematics: Analysis I and II, algebra
2. Elemental physics: Physics I and II
3. Elemental chemistry: General chemistry, introductory inorganic chemistry
4. The English language

SUBJECT OBJECTIVES

C1 Application of thermodynamics for description of chemical reactions

C2 Elements of laboratory methods using the principles of phase equilibria: distillation, crystallization, extraction, chromatography

C3 Electrochemical mesaurements in laboratory: potentiometry, conductometry, polarography, amperometry

C4 Application of formal kinetic rate laws to describe rates of real world chemical reactions

SUBJECT LEARNING OUTCOMES

Relating to knowledge:

A person who passed the subject

PEK_W01 – knows fundamentals of thermodynamics

PEK_W02 – knows fundamentals of the description of phase transitions

PEK_W03– knows fundamentals of the functioning of electrochemical cells and the basic behavior of ions in water solutions

PEK_W04– knows fundamentals of chemical kinetics

Relating to skills:

A person who passed the subject

PEK_U01 – can solve elementary thermodynamics problems: computation of the reaction heat, computation of the equilibrium constant

PEK_U02– can compute phase transition effects: vapor pressure depnding on the conditions, the coposition of the distilate etc.

PEK_U02– can compute the electromotive force of cells, values of pH of solutions, solubility of a salt in water etc.

PEK_U02– can calculate reaction rate constant, order of reaction and its activation energy based upon results of the dependence of concentration on time at different temperatures.

Relating to social competences:

A person who passed the subject

PEK_K01 – possesses ability of combining information from disparate fields of science (mathematics,physics, chemistry) to arrive at coherent conclusions

PEK_K02– is prepared to carry out computations involving elementary numerical methods in physical chemistry and can assess objectively the validity of the obtained result.

PROGRAMME CONTENT

Form of classes - lecture		Number of hours
Lec 1	Chemical thermodynamics. Heat and work. 1st law of thermodynamics. Thermochemistry.	2
Lec 2	2nd law of thermodynamics. Entropy, free energy and free enthalpy.	2
Lec 3	Chemical potential and chemical affinity. Chemical equilibrium. van't Hoff's isobar.	2
Lec 4	Kinetic theory of gases. Equations of state. Real gases, fugacity.	2
Lec 5	Phase equilibria. Gibbs' phase rule. Phase equlibria in one-component system (Clausius-Clapeyron equation).	2
Lec 6	Two-component systems. Liquid-vapor equilibrium (Raoult's and Henry's equations). Distillation. Liquid-liquid equilibrium. Liquid-solid equilibrium.	2
Lec 7	Three-component systems. Nernst's partition coefficient. Extraction.	2
Lec 8	Surface phenomena. Adsorption. Adsorption isotherms. Chromatography. Surface tension.	2
Lec 9	Dispersed systems. Electrokinetic phenomena. Properties of colloids. Transport phenomena: diffusion, viscous flow.	2
Lec 10	Electrochemistry. Electrochemical cells. Electromotive force. electrochemical potentials. Cells as sources of energy.	2
Lec 11	Conductivity of electrolyte solutions. Electrolysis. Polarography. Electrochemical methods in chemical analysis.	2
Lec 12	Chemical kinetics. Reaction rate. Formal kinetics: reaction order. Non-elementary reactions.	2
Lec 13	Temperature dependence of reaction rates. Activation energy. Theoretical description.	2
Lec 14	Homogeneous and heterogeneous catalysis. Autocatalytic reactions. Kinetics of ionic reactions. Kinetics of reactions in multiphase systems.	2
Lec 15	Kinetics of reactions in solids / Osmotic phenomena.	2
	Total hours	**30**
Form of classes - class		Number of hours
Cl 1	1st law of thermodynamics. Calculations of work, heat, and changes of internal energy and enthalpy.	2
Cl 2	Calculating heats of chemical reactions. Hess and Kirchhoff's laws.	2
Cl 3	Entropy, free energy and free enthalpy. 2nd law of thermodynamisc applied to chemical reactions. Chemical affinity of reaction. Chemical potential of a component.	2
Cl 4	Chemical equilibria. Equilibrium constants, temperature ans pressure dependences. van't Hoff's isobar. Equilibria in real systems.	2
Cl 5	Phase equilibria in one-component systems. Phase diagrams. Clausius-Clapeyron equation.	2
Cl 6	Phase equilibria in multicomponent systems. Phase rule.	2
Cl 7	Two component systems: two liquids and liquid-vapour equilibria. Raoult and Henry’s laws. Distillation. Two-component solid-liquid systems. osmotic phenomena. Three-component systems. Gibbs's triangle.	2
Cl 8	1st written test	2

Cl 9	Surface phenomena. Adsorption on solid surfaces. Surface tension. Szyszkowski and Gibbs equations.	2
Cl 10	Ionic equilibria in solutions. Activities. Calculations of pH and of concentrations in acid-base equilibria.	2
Cl 11	Electromotive force and electrode processes. Reactions and Nernst equations for typical half-cells. Calculating thermodynamic functions from EMF. Calculating solubility product from EMF.	2
Cl 12	Electrical conduction of electrolyte solutions. Determination of ion mobilities. Calculations of electrolytic conductivity and molar conductivity of strong and weak electrolytes.	2
Cl 13	Determination of solubility product from measurements of conductivity. Determination of transfer numbers.	2
Cl 14	Formal kinetics of elementary reactions. Determination of orders and rate constants of simple reactions.	2
Cl 15	Final (2nd) test	2
	Total hours	**30**

TEACHING TOOLS USED	
N1	Lecture: multimedial presentation
N2	Lecture: multiple choice test
N3	Classes: a set of computational problems, presented to teh students for individual elaboration and discussed during the class
N4	Class: a traditional written test

EVALUATION OF SUBJECT LEARNING OUTCOMES ACHIEVEMENT

Evaluation (F – forming (during semester), P – concluding (at semester end)	Learning outcomes number	Way of evaluating learning outcomes achievement
F1	PEK_U01, PEK_U02	Test 1
F2	PEK_U03, PEK_U04	Test 2
F3	PEK_W01 PEK_W02 PEK_W03 PEK_W04 PEK_K01 PEK_K02	Exam

P= 0,3(F1+F2)+0,4F3

Condition of passing: P=50% or more

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] Peter Atkins, Julio De Paula, "Atkins' Physical Chemistry", Eighth edition, Oxford University Press, Oxford 2006

[2] Peter Atkins and Julio de Paula, „Atkins' Physical Chemistry”, Ninth Edition, Oxford University Press, Oxford 2009

[3] Charles Trapp, Marshall Cady, and Carmen Giunta, „Student's solutions manual to accompany Atkins' Physical Chemistry 9/e”, Oxford University Press, Oxford 2010

SECONDARY LITERATURE:

[1] H. Kuhn i H.-D. Försterling, Principles of Physical Chemistry. Understanding Molecules, Molecular Assemblies, Supramolecular Machines, J. Wiley, Chichester 1999

[2] Clifford E. Dykstra, Physical Chemistry: A Modern Introduction, CRC Press, 2012

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

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