Załącznik do zarządzenia nr 110 Rektora UMK
z dnia 17 lipca 2013 r.

Formularz opisu przedmiotu (formularz sylabusa) na studiach wyższych, doktoranckich, podyplomowych i kursach dokształcających

A. Ogólny opis przedmiotu

Nazwa pola	Komentarz
Name of the subject (in Polish and English)	**Chemia Fizyczna** **Physical chemistry**
Unit offering the subject	Faculty of Chemistry
Unit for which the subject is offered	Faculty of Chemistry, course: chemistry
Subject code	0600-S1-EN-O-CFIZ
ERASMUS code	
Number of ECTS credits	18 ECTS
Method of assessment	lecture – oral examination tutorial – graded credit laboratory – graded credit
Language of instruction	English
Designation whether a subject may be credited more than once	No
Allocation of the subject to subject groups	Obligatory course
Total student workload	Contact hours with teacher - 210 contact hrs: - participation in lectures - 75 hrs - tutorials – 45 hrs - laboratory – 90 hr Self-study hours: - preparation for lectures – 30 hrs - preparation for tutorials - 60 hrs - writing laboratory reports – 90 hrs - preparation for the assessment - 60 hrs Altogether: 450hrs (18ECTS) 50h: 450hrs/ECTS = 18 ECTS
Learning outcomes - knowledge	Student: W1: knows states of the amtter – K_W08 W2: knows the equation of state – K_W08 W3: knows laws of thermodynamics – K_W08 W4: knows interactions between molecules – K_W08 W5: knows the phase equilibria – K_W08 W6: knows basics of kinetics – K_W08 W7: knows basics of electrochemistry – K_W08
Learning outcomes - skills	Student: U1: possesses the abilities of measuring the basic chemical and physicochemical constants – K_U05 U2: can elaborate and discuss the results of experimental results – K_U05 U3: can solve the basic mathematical problems associated with thermodynamics, kinetics, electrochemistry – K_U05 U4: is able to prepare a written report associated with results of performed experiments - K_U17.
Learning outcomes - social	Student:

competencies	K1: possesses the ability of the analytical thinking, works with big amount of data, is able to make the logical conclusions– K_K01 K2: is conscientious, thorough and systematic, shows the positive altitude to solve the problems – K_K01, K_K02 K3: is prepared to acquire new knowledge, understands the need for continuous improvement of professional competence - K_K05.
Teaching methods	**Lecture:** Conventional lecture using multimedia presentations. **Tutorial** Team working, round table discussion, seminar **Laboratory** Team working, round table discussion, poster session
Prerequisites	Basic knowledge of general chemistry, analytical chemistry and mathematics
Brief description of the subject	Basics of the equilibrium thermodynamics, laws of thermodynamics, criteria of the behavior of systems Chemical potential of the component. Chemical reaction equilibrium. Phase change equilibria. Properties of matter (gas, liquids, solids). Properties of the interphase surfaces. Conductivity of electrolytes. Electrochemical cells. Polarization of electrodes. Corrosion. Chemical kinetics, mechanism of chemical reactions. Catalysis.
Complete description of the subject	Lecture: 75 hrs; tutorials (problem solving) 45 hrs; laboratory 90 hrs. Lecture: 01: States of the matter - part 1 02: States of the matter - part 2 03: States of the matter - part 3 04: Laws of thermodynamics - (work and heat, internal energy) 05: Laws of thermodynamics – (enthalpy, Hess' and Kirchoff's laws) 06: Laws of thermodynamics – (entropy) 07: Laws of thermodynamics – (free Gibbs' enthalpy, chemical equilibrium) 08: Phase equilibria, phase diagrams, pure substance 09: Phase equilibria – nonelectrolyte solutions, colligative properties. 10: Phase equilibria of binary and ternary systems (azeotropic mixtures, systems with miscibility gap) 11: Kinetics – basic relations, rate equation 12: Kinetics – 1st and 2nd order reactions, influence of temperature on the rate of the reaction, theoretical basics of chemical kinetics, katalysis. 13: Kinetics – mechanisms of chosen chemical reactions. 14: Electrochemistry – electrochemical cells, electrode reactions, types of electrodes, therodynamics of the electrochemical cells, Nerst equation. 15. Electrochemistry – redox potentials, influence of pH on the redox potential, determination of entropy on the basis of SEM measurements. 16. Electrochemistry – electrolyte solutions, basic characteristics, Kohlrausch's law, electrolysis, Faraday's law, transport numbers, mobility of ions. 17. Electrochemistry – activity of electrolytes, Debye- Hűckel's theory, hydration of ions, electrochemical potential. 18. Molecules in motion – gases, liquids (effusion, diffusion, viscosity, thermal conductivity) Laboratory experiments 1. Heat of dilution, calorimetric constant

	2. Heat effect of the neutralization reaction of weak acid (differential microcalorimeter) 3. Determination of the partial molar volumes for the system water-ethanol 4. Ebuliometric determination of the molar mass or osmotic coefficient. 5. Nernst law. Partition coefficient. 6. Determination of the phase diagram for the condensed two-component system. 7. Determination of the solubility isotherm for the system of 3 solvents (Gibbs' diagram). 8. Correlation between surface tension and concentration of surface active substances. Gibbs' adsorption isotherm. 9. Sorption from solutions on the active carbon. 10. Refraction of the solutions. 11. Influence of temperature on the solvent viscosity. Ostwald viscometer. 12. Spectrophotometric method of the determination of the dissociation constant of the pH indicators. 13. Electrochemistry – electromotive force of cells. Determination of the solubility constant of silver halides. 14. Changes of the thermodynamic functions of the electrochemical cell reactions (enthalpy, entropy, free Gibbs energy). 15. Electrochemical determination of entropy of solution mixing 16. Electrochemical determination of the dissociation constant of weak acids. 17. Correlation between the conductivity and concentration of strong electrolytes. 18. Conductivity of water and weak electrolytes. Determination of the dissociation constant of weak acid. 19. Voltamperometric determination of the rate of oxygen transport through the air-solution phase. 21. Kinetics of the esters hydrolysis in the acidic environment. 22. First order reaction – saccharose hydrolysis 23. Kinetics of oxidation reaction of iodide ions by persulphate ions. 24. Catalysis – determination the rate constant of the decomposition of hydrogen peroxide on active carbon catalyst 25. Determination of the Tafel's equation. 26. Determination of water activity and osmotic coefficient of water in the hydrochloric acid solutions. 27. Determination of the diffusion coefficient for the 2 component system. Tutorials (problem solving) 1. Calculations of work and heat during simple physical changes, heat capacity. 2. Function of state, changes of internal energy and enthalpy of the systems. 1st law of thermodynamics. 3. Changes of internal energy and enthalpy during chemical reactions, heat of reaction, heat of combustion, heat of creation, Hess' law. 4. Influence of temperature on the heat of reaction – Kirchoff's law. 5. 2nd law of thermodynamics – calculation of the entropy changes of physical changes and chemical reactions. Influence of temperature. 6. Calculations of the enthalpy and free energy of physical processes and chemical reactions. 7. Thermodynamic equilibrium, equilibrium constant, influence of temperature and pressure, Le Chatelier-Braun rule. 8. Calculations of equilibrium constant of various reactions.

	9. Chemical kinetics - calculating the rate constant of the reactions and the progress of elementary reactions; rate constant dependence on the temperature - Arrhenius equation 9. Electrochemistry – electrolyte conductivity, electromotive force, Nernst' equation, calculation of the changes of thermodynamic functions of various chemical reactions.
Literature	**Literature:** P.Atkins, Elements of Physical Chemistry, Oxford University Press P.Atkins, Physical Chemistry, Oxford University Press D.Smith – Solution manuals to Elements of Physical Chemistry, Oxford University Press
Assessment methods & criteria	**Lecture:** oral exam, **Tutorials**: graded credit; **Laboratory**: graded credid W08, U05,U17, K01,K02,K05 **Assessment criteria:** Thresholds evaluate compatibles with the rules of UMK **Lecture:** oral examination (5 questions over the set of 100) Laboratory: written tests and assessment of written reports Tutorial: results of 3 written tests (4-6 problems to solve) satisfactory - 50-60%, satisfactory plus - 61-65%, good - 66-75%, good plus - 76-81%, very good - 82-100%
Work placement	not applicable

B) Opis przedmiotu cyklu

Nazwa pola	Komentarz
Didactic cycle	2014/2015
Method of assessment of the subject in the cycle	*lecture- oral examination* *tutorial – graded credit* *laboratory – graded credit*
Type of classes, number of hours of classes and methods of assessment	**Lecture** - 75 hrs; oral examination **Tutorials** – 45 hrs; written test; graded credit **Laboratory** – 90 hrs; written tests; reports; graded credit
Subject coordinator	*dr hab. Wojciech Kujawski, prof. UMK*
Subject teachers	*Lecture: dr hab. Wojciech Kujawski, prof. UMK* *Tutorials: dr hab. Wojciech Kujawski, prof. UMK* *Laboratory: dr Izabela Koter*
Nature of the subject	Obligatory
	Lecture group - all students Tutorial groups – up to 25 students Laboratory groups – up to 10 students
Time and place	Faculty of Chemistry, date will be specified later
Learning outcomes	As in part A
Assessment methods & criteria	As in part A
List of topics	Lecture: 75 hrs; tutorials (problem solving) 45 hrs; laboratory 90 hrs. Lecture: 01: States of the matter - part 1 02: States of the matter - part 2

	03: States of the matter - part 3 04: Laws of thermodynamics - (work and heat, internal energy) 05: Laws of thermodynamics – (enthalpy, Hess' and Kirchoff's laws) 06: Laws of thermodynamics – (entropy) 07: Laws of thermodynamics – (free Gibbs' enthalpy, chemical equilibrium) 08: Phase equilibria, phase diagrams, pure substance 09: Phase equilibria – nonelectrolyte solutions, colligative properties. 10: Phase equilibria of binary and ternary systems (azeotropic mixtures, systems with miscibility gap) 11: Kinetics – basic relations, rate equation 12: Kinetics – 1st and 2nd order reactions, influence of temperature on the rate of the reaction, theoretical basics of chemical kinetics, catalysis. 13: Kinetics – mechanisms of chosen chemical reactions. 14: Electrochemistry – electrochemical cells, electrode reactions, types of electrodes, thermodynamics of the electrochemical cells, Nernst equation. 15. Electrochemistry – redox potentials, influence of pH on the redox potential, determination of entropy on the basis of SEM measurements. 16. Electrochemistry – electrolyte solutions, basic characteristics, Kohlrausch's law, electrolysis, Faraday's law, transport numbers, mobility of ions. 17. Electrochemistry – activity of electrolytes, Debye- Hűckel's theory, hydration of ions, electrochemical potential. 18. Molecules in motion – gases, liquids (effusion, diffusion, viscosity, thermal conductivity) Laboratory experiments 1. Heat of dilution, calorimetric constant 2. Heat effect of the neutralization reaction of weak acid (differential microcalorimeter) 3. Determination of the partial molar volumes for the system water-ethanol 4. Ebulliometric determination of the molar mass or osmotic coefficient. 5. Nernst law. Partition coefficient. 6. Determination of the phase diagram for the condensed two-component system. 7. Determination of the solubility isotherm for the system of 3 solvents (Gibbs' diagram). 8. Correlation between surface tension and concentration of surface active substances. Gibbs' adsorption isotherm. 9. Sorption from solutions on the active carbon. 10. Refraction of the solutions. 11. Influence of temperature on the solvent viscosity. Ostwald viscometer. 12. Spectrophotometric method of the determination of the dissociation constant of the pH indicators. 13. Electrochemistry – electromotive force of cells. Determination of the solubility constant of silver halides. 14. Changes of the thermodynamic functions of the electrochemical cell reactions (enthalpy, entropy, free Gibbs energy).

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Teaching methods	As in part A
Literature	As in part A