EKSPERIMENTALNA FIZIKALNA KEMIJA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Eksperimentalna fizikalna kemija
Course title:	Experimental physical chemistry
Članica nosilka/UL Member:	UL FKKT

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Kemija, druga stopnja, magistrski	Ni členitve (študijski program)	1. letnik, 2. letnik		izbirni

Univerzitetna koda predmeta/University course code:	0072230
Koda učne enote na članici/UL Member course code:	K2I17

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
30	20	25 LV			75	5

Nosilec predmeta/Lecturer:	izr. prof. dr. Janez Cerar, prof. dr. Jurij Lah, prof. dr. Matija Tomšič
Vrsta predmeta/Course type:	izbirni strokovni/Elective Professional
Jeziki/Languages:	Predavanja/Lectures: Angleščina, Slovenščina Vaje/Tutorial: Angleščina, Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Študent oz. kandidat mora imeti predmet opredeljen kot študijsko obveznost.	The course has to be assigned to the student.

Vsebina:	Content (Syllabus outline):
Izotermna kalorimetrija Fizikalne osnove signala, merjenje in analiza signala, razredčilna toplota, titracije, uporabnost pri študiju vezanja molekul. **Diferenčna dinamična kalorimetrija** Fizikalne osnove signala, merjenje in analiza signala, uporabnost pri študiju strukturnih sprememb makromolekul. **Spektropolarimetrija** Polarizirana svetloba, molekularne osnove signala, merjenje in analiza signala, titracije, uporabnost pri študiju (inducirane) asimetrije molekul. **Fluorimetrija**	**Isothermal calorimetry** Physical basics of the signal, measurement and analysis of the signal, heat of dilution, titrations, usefulness in the study of the molecular binding. **Differential scanning calorimetry (DSC)** Physical basis of the signal, measurement and analysis of the signal, usefulness in the study of structural changes of macromolecules. **CD-spectroscopy** Polarized light, circular dichroism (CD), molecular basis of the signal, measurement and signal analysis, CD - titration usefulness in the study of (induced) asymmetry of the molecules. **Fluorimetry**

Molekularne osnove signala, merjenje in analiza signala, uporabnost pri študiju vezanja in strukturnih sprememb molekul. **Osnove metod sipanja** Uvod v statično in dinamično sipanje laserske svetlobe ter ozkokotno rentgensko sipanje, eksperimentalni sistemi, aplikacija, analiza in interpretacija rezultatov sipanja **Osmometrija** določanje molskih mas, osmoznih koeficientov in virialnih koeficientov z raznimi tipi osmometrov **Konduktometrične metode** Fizikalne osnove merjenja prevodnosti in transportnih števil v ionskih raztopinah, uporabnost pri določevanju stopnje vezave protiionov na polielektrolit. **Ionoselektivne elektrode** Fizikalne osnove, klasifikacija, priprava elektrod, uporabnost pri študijah koeficientov aktivnosti enostavnih elektrolitov in surfaktantov. **Eksperimentalne osnove merjenja fizikalnih lastnosti tekočin** (gostota, površinska napetost, reološke lastnosti, viskoznost) **Difuzija in dinamika molekul v raztopinah** Koeficient lastne difuzije, koeficient kemijske difuzije. Pomen koeficienta difuzije pri proučevanju transportnih in asociacijskih pojavov v raztopinah. Eksperimentalno določanje koeficientov difuzije. Raziskave dinamike molekul z NMR metodami.	Molecular basis of the signal, measurement and analysis of the signal, usefulness in the study of binding and structural changes of molecules. **Basics of scattering methods** Introduction to static and dynamic laser light scattering and small angle X-ray scattering, experimental systems, applications, data analysis and interpretation of the results. **Osmometry** Determination of molecular weights, osmotic coefficients and virial coefficients using various types of osmometers **Conductometric methods** Physical basics of conductivity and transference number measurements of ionic solutions, usefulness in determining the degree of binding of counterions to the polyelectrolyte. **Ion-selective electrodes** Physical basis, classification, preparation of electrodes, usefulness in studies of activity coefficients of simple electrolytes and surfactants. **Experimental basis of measuring physical properties of liquids** (density, surface tension, rheological properties, viscosity) **Diffusion and dynamics of molecules in solutions** Coefficient of self-diffusion, coefficient of chemical diffusion. The importance of diffusion coefficient when considering transport and association phenomena in solution. Experimental determination of diffusion coefficients. Studies of molecular dynamics NMR methods.

Temeljna literatura in viri/Readings:

- Biocalorimetry, J.E Ladbury. in B.Z. Chowdhry, J. Wiley & Sons (1998), 345 str., (20 %).
- Principles of Physical Biochemistry, K.E. van Holde, Prentice Hall (1998), 657 str., (5 %).
- Biophysical Chemistry, A. Cooper, RSC, Cambridge (2004), 184 str., (10 %).
- Physical chemistry, W.J. Moore, Addison Wesley Longman (1996), 977 str. , (5 %).
- Small Angle X-ray Scattering, O. Glatter, O. Kratky, Academic Press (1982), 514 str., (25 %)
- Neutrons, X-rays and Light: Scattering Methods Applied to Soft Condensed Matter, P. Lindner in T. Zemb, Elsevier (2002), 541 str., (15 %).
- Polyelectrolytes, H. Dautzenberg, Hanser Publishers (1994), 343 str., (5%).
- Physical Methods of Chemistry: Electrochemical Methods, urednika B.W. Rossiter in J.F. Hamilton, J. Wiley & Sons (1986), 2. izdaja, 904 str.
- Experiments in Physical Chemistry, C. W. Garland, J. W. Nibler in D. P. Shoemaker, McGraw-Hill (2009), 8. izdaja, 734 str.

Dopolnilna literatura:
- Light Scattering Principles and Development, W. Brown,Claredon Press (1996), 528 str.
- Scattering in Polymeric and Colloidal Systems, W. Brown, K. Mortensen, Gordon and Breach Science Publishers (2000), 592 str.
- Light Scattering from Polymer Solutions and Nanoparticle Dispersions, Wolfgang Schaertl, Springer Verlag (2010), 205 str.

Cilji in kompetence:	**Objectives and competences:**
Cilj predmeta je študentom predstaviti osnovne koncepte različnih eksperimentalnih metod in inštrumentov, ki se uporabljajo na področju fizikalne	The aim of the course is to introduce the basic concepts of different experimental methods and instrumentation used in the field of physical

kemije, jih podrobneje seznaniti z eksperimentalnimi veščinami ter aplikacijami teh metod in jih spodbuditi, da pridobljeno znanje in izkušnje s pridom uporabljajo pri svojem bodočem delu. Študentje pri predmetu pridobijo naslednje specifične *kompetence:* - razumevanje teorijskega ozadja eksperimentalnih metod in inštrumentov, - sposobnost presoje in pravilnega pristopa k uporabi različnih eksperimentalnih metod v fizikalni kemiji, - sistematičnost pristopa pri reševanju projektne naloge, - usposobljenost za samostojno delo na inštrumentih uporabljenih pri projektni nalogi in za izdelavo poročil.	chemistry, to acquaint students with the experimental skills and applications of these methods and to encourage students to use this knowledge and experience in their future work. Students of the course gain the following specific competencies: - Understanding of theoretical background of experimental methods and instrumentation, - Judgment and the proper approach to the use of different experimental methods in physical chemistry, - A systematic approach in solving experimental problems - Ability to work independently with the instruments in the labwork and to write reports.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje Osnovno teorijsko in praktično znanje ter razumevanje raznih eksperimentalnih tehnik v fizikalni kemiji: kalorimetrija, spektrometrija, statično in dinamično sipanje, osmometrija, površinska napetost, viskoznost, gostota, prevodnost, mikroskopija, … Poznavanje osnov analize in interpretacije rezultatov meritev pri posamezni metodi. Uporaba Uporaba kalorimetričnih, spektrometričnih in osmometričnih metod, metod sipanja in drugih fizikalnih metod za določitev fizikalnih lastnosti raznih bioloških in koloidnih sistemov, raznih raztopin ter fizikalnih značilnosti kemijskih reakcij oziroma procesov. Refleksija Študent bo pridobil občutek za povezavo med teorijskim ozadjem določene metode, inštrumentom in eksperimentalno izvedbo meritev. S pridobljenim znanjem bo kritično presodil in ovrednotil rezultate eksperimentalnih vaj in projektne vaje. Prenosljive spretnosti Sistematičnost pristopa pri reševanju projektne naloge, zbiranje literature, ovrednotenje in poročanje o rezultatih projekta.	Knowledge and Comprehension Theoretical and practical knowledge and understanding of various experimental techniques in physical chemistry: calorimetry, spectroscopy, static and dynamic scattering, osmometry, surface tension , viscosity, density, conductivity, microscopy. Knowing the basis of analysis and interpretation of measurement results for each method. Application Using calorimetric, spectroscopic, osmometric, scattering and other physical methods for determining the physical properties of various biological and colloidal systems, solutions and various physical properties of chemical reactions and processes. Analysis Students will gain a feeling for connection between the theoretical background of a particular method, instrument and experimental measurement. The knowledge gained will enable students to critically evaluate the results of experimental work. Skill-transference Ability Systematic approach to solving the experimental problems, collecting of literature, evaluating and reporting on the results of the project.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja, eksperimentalne praktične vaje, projektna vaja.	Lectures, seminars, laboratory exercises.

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Pisni izpit po uspešno opravljenih vajah. Ocene: pozitivno (6-10), negativno (1-5).		Written examination after successful completion of laboratory exercises. Grades: (6-10) pass, (1-5) fail.

Reference nosilca/Lecturer's references:

LAH, Jurij, POHAR, Ciril, VESNAVER, Gorazd. Calorimetric study of the micellization of alkylpyridinium and alkyltrimethylammonium bromides in water. J. Phys. Chem., B Mater. surf. interfaces biophys., 2000, vol. 104, no. 11, str. 2522-2526.
LAH, Jurij, MAIER, Norbert M., LINDNER, Wolfgang, VESNAVER, Gorazd. Thermodynamics of binding of (R)- and (S)-dinitrobnzoyl leucine to cinchona alkaloids and their tert-butylcarbamate derivatives in methanol : evaluation of enantioselectivity by spectroscopic (CD, UV) and microcalorimetric (ITC) titrations. J. Phys. Chem., B Mater. surf. interfaces biophys., 2001, vol. 105, no. 8, str. 1670-1687.
DROBNAK, Igor, VESNAVER, Gorazd, LAH, Jurij. Model-based thermodynamic analysis of reversible unfolding processes. J. Phys. Chem., B Condens. mater. surf. interfaces biophys., 2010, vol. 114, no. 26, str. 8713-8722.
CERAR, Janez, ŠKERJANC, Jože: Electric transport and ion binding in solutions of fullerenehexamalonic acid Th-C66(COOH)12 and its alkali and calcium salts. J. Phys. Chem. B, 2008, 112, str. 892-895.
CERAR, Janez, URBIČ, Tomaž: Viscosity and electrophoretic mobility of cesium fullerenehexamalonate in aqueous solutions : comparing experiments and theories on nanometer-sized spherical polyelectrolyte. J. Phys. Chem. B, 2008, 112, str. 12240-12248.
ŠKERJANC, Jože, KOGEJ, Ksenija, CERAR, Janez: Equilibrium and transport properties of alkylpyridinium bromides. Langmuir, 1999, 15, str. 5023-5028.
TOMŠIČ, Matija, BEŠTER-ROGAČ, Marija, JAMNIK, Andrej, KUNZ, Werner, TOURAUD, Didier, BERGMANN, Alexander, GLATTER, Otto. Nonionic surfactant Brij 35 in water and in various simple alcohols : structural investigations by small-angle x-ray scattering and dynamic light scattering. J. phys. chem., B Condens. mater. surf. interfaces biophys., 2004, vol. 108, no. 22, str. 7021-7032
TOMŠIČ, Matija, JAMNIK, Andrej, FRITZ, Gerhard, GLATTER, Otto, VLČEK, Lukáš. Structural properties of pure simple alcohols from ethanol, propanol, butanol, pentanol, to hexanol : comparing Monte Carlo simulations with experimental SAXS data. J. phys. chem., B Condens. mater. surf. interfaces biophys., 2007, vol. 111, no. 7, str. 1738-1751.
TOMŠIČ, Matija, GLATTER, Otto. From bulk to dispersed hierarchically organized lipid phase systems. V: IGLIČ, Aleš (ur.). Advances in planar lipid bilayers and liposomes : volume 12, (Advances in planar lipid bilayers and liposomes). Amsterdam; Elsevier: Academic Press, cop. 2010, str. 167-200.