UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	IZBRANA POGLAVJA IZ EKSPERIMENTALNE FIZIKALNE KEMIJE
Course Title:	SELECTED TOPICS IN EXPERIMENTAL PHYSICAL CHEMISTRY

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
DR Kemijske znanosti, 3. stopnja	**/**	**1.**	**1. in 2.**
Doctoral programme in Chemical Sciences, 3rd Cycle	**/**	**1st**	**1st and 2nd**

Vrsta predmeta / Course Type: izbirni/Elective

Univerzitetna koda predmeta / University Course Code: KZ306

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Work	Druge oblike študija	Samost. delo Individual Work	ECTS
	30	**15 LV /30 SV**			**75**	**5**

Nosilec predmeta / Lecturer: prof. dr. Miha Lukšič/Dr. Miha Lukšič, Full Professor

Jeziki / Languages:

Predavanja / Lectures:	**slovenski / Slovenian**
Vaje / Tutorial:	**slovenski / Slovenian**

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):
Študent skupaj z mentorjem izbere vsebine v obsegu 5 KT izmed spodaj navedenih, nosilec predmeta skladno z izbranimi vsebinami kooordinira izvajanje, če je izvajalcev več. - *Raztopine biološko pomembnih makromolekul.* Termodinamika in kinetika vodnih raztopin biopolimerov. Modelska analiza termodinamskih in kinetičnih količin merjenih s spektroskopskimi in kalorimetričnimi metodami v povezavi s strukturo in delovanjem bioloških makromolekul. - *Strukturne raziskave nano-sistemov z metodo ozkokotnega rentgenskega sipanja.* Splošna teorija rentgenskega sipanja. Modelni izračuni:	From the topics listed below the student selects (in agreement with the supervisor) those that are mostly related to his research work. The course coordinator, who is in charge of the course, and the leader of the study take care that the student's workload corresponds to 5 credits. If more persons are taking the study programme, the whole process is coordinated by course coordinator. - *Solutions of biologically important macromolecules.* Thermodynamics and kinetics of biopolymers in aqueous solutions. Model analysis of thermodynamic and kinetic quantities measured by spectroscopic and calorimetric techniques in correlation with

sferični, paličasti in ploščati delci. Eksperimentalni sistem. Analiza eksperimentalnih podatkov. Primeri uporabe. - *Raziskava ergodijskih in neergodijskih sistemov z metodo SLS in različnimi inačicami metode DLS.* Splošna teorija sipanja laserske svetlobe. Specifične lastnosti eksperimentalnih sistemov običajne, 3D, 'echo' in 'multi-speckle' inačice DLS. Analiza eksperimentalnih podatkov. Primeri uporabe. - *Termodinamske raziskave asociacijskih procesov v raztopinah.* Asociacija ionov v raztopinah elektrolitov. Termodinamika micelizacije ionskih in neionskih površinsko aktivnih snovi (izotermna titracijska kalorimetija, izotermna titracijska konduktometrija, Philipsov kriterij, psevdofazni separacijski model, ravnotežni model, določanje stopnje ionizacije micel). - *Kompleksni koloidni sistemi.* Asociirajoči sistemi: surfaktanti, polimeri in polielektroliti ter mešani sistemi. Medmolekulska asociacija in geliranje. Fazno obnašanje in strukture. Eksperimentalne tehnike za študij asociacije. - *Vodne raztopine polielektrolitov.* Sintezni principi in analiza vzorcev polielektrolitov. Osnovna karakterizacija polielektrolitov: določanje topnostnih krivulj, ionizacijske konstante, titracijske krivulje. Modelska analiza izmerjenih termodinamskih in transportnih lastnosti polielektrolitov v povezavi s strukturo polielektrolita.	structure and function of biological macromolecules. - *Structural investigation of nano-systems by small angle x-ray scattering.* General scattering theory. Model calculations: Spherical, rod-like and flat particles. Experimental setup. Data treatment and evaluation. Practical applications. - *Investigation of ergodic and non-ergodic systems by SLS and various DLS methods.* General theory of light scattering. Specific properties of auto-correlation, 3D, echo, and multi-speckle DLS experimental systems. Practical applications. - *Thermodynamics of the association processes in solutions.* Ion association in the electrolyte solutions. Thermodynamic of micelle formation of ionic and non-ionic surfactants (isothermal titration calorimetry, isothermal titration conductometry, Philips's criterion, pseudo-phase separation model, equilibrium model, degree of ionization of the micelles. - *Complex colloid systems.* Associating systems: surfactants, polymers and polyelectrolytes, and mixed polymer-surfactant systems. Intermolecular association and gelation. Phase behavior and structures. Experimental techniques for studying associating systems. - *Aqueous solutions of polyelectrolytes.* Principles of synthesis and analytics of polyelectrolytes samples. Basic characterization of polyelectrolytes: determination of solubility curves, ionization constants, titration curves. Model analysis of measured thermodynamic and transport properties of polyelectrolytes in correlation with the polyelectrolyte structure.

Temeljna literatura in viri / Readings:

Aktualna klasična in najnovejša literatura (monografije, članki) z izbranega študijskega področja. / Relevant classical and modern literature (books, scientific articles) from the chosen research field.

Cilji in kompetence:	**Objectives and Competences:**
V okviru tega predmeta študent pridobi specialistična znanja z ožjega področja. Ta znanja zadostujejo za samostojno vodenje	During the learning process students acquire high-level knowledge from a narrow focused scientific field. With the experience they gain

znanstvene raziskave na izbranem raziskovalnem področju.	they will be able to carry out research autonomously in a chosen research field.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
Znanje in razumevanje Predmet združuje teorijsko in praktično znanje z razumevanjem ter uporabo raznih eksperimentalnih tehnik v fizikalni kemiji: kalorimetrija, spektrometrija, meritve električne prevodnosti, statično in dinamično sipanje, itd. Študentje se seznanijo z analizo in interpretacije rezultatov meritev pri posamezni metodi.	Knowledge and Comprehension The course combines theoretical and practical knowledge to the understanding and application of various experimental techniques in physical chemistry: calorimetry, spectroscopy, electrical conductivity measurements, static and dynamic scattering, etc. . Students are introduced to the analysis and interpretation of experimental results at each method.
Uporaba Študentje se poglobljeno seznanijo z uporabo 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.	Application Students are deeply introduced to the application of calorimetric and spectrometric method, osmometry, scattering and other physical methods to determine the physical properties of various biological and colloidal systems, solutions and various physical characteristics of chemical reactions and processes.
Refleksija Študent pridobi občutek za povezavo med teorijskim ozadjem določene metode, inštrumentom in eksperimentalno izvedbo meritev. S pridobljenim znanjem bo kritično presodil in ovrednotil eksperimentalne rezultate v okviru raziskovalnega dela.	Analysis Student obtains a sense for connection between the theoretical background of a specific method, instrument and experimental implementation of measurement. The gained knowledge will help him at critically assessment and evaluation of the experimental results in the context of research work.
Prenosljive spretnosti Predmet nadgrajuje sistematičnost pristopov pri izvajanju raziskovalnih projektov z ovrednotenjem in poročanjem o rezultatih pridobljenih z različnimi eksperimentalnimi tehnikami.	Skill-transference Ability The course upgrades systematic approaches in the implementation of research work by evaluating and reporting on the results obtained by different experimental techniques.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Metode so prilagojene študentu oziroma skupini: predavanja, študij ustrezne strokovne literature, laboratorijsko delo na izbranem področju in razprave v ožji skupini.	Literature study, problem-based work in a laboratory, and discussions in the research group.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Način preverjanja znanja se dogovori individualno z vsakim študentom		The assessment method is determined in agreement with every single student

doktorskega študija in se lahko izvaja v obliki ustnega in/ali pisnega izpita, seminarja ali izdelave projekta oziroma pisanja znanstvenega članka.	50 % 50 %	and can be carried out as an oral and/or written exam, a seminar work, a project work, or writing a scientific article.

Reference nosilca / Lecturer's references:

[1] B. Hribar-Lee, M. Lukšič. Biophysical principles emerging from experiments on protein–protein association and aggregation. Annu. Rev. Biophys. 2024, 53, 1.
[2] M. Simončič, J. Hritz, M. Lukšič. Biomolecular complexation on the “wrong side”: a case study of the influence of salts and sugars on the interactions between bovine serum albumin and sodium polystyrene sulfonate. Biomacromolecules 2022, 23, 4412.
[3] T. Gao, J.-P. Krob, M. Lukšič, G. Mériguer, N. Malikova, A.-L. Rollet. Ion influence on surface water dynamics and proton exchange at protein surfaces - a unified model for transverse and longitudinal NMR relaxation dispersion. J. Mol. Liq. 2022, 367, 120451.