| UČNI NAČRT PREDMETA / COURSE SYLLABUS | |
|---|---|
| **Predmet:** | FIZIKALNA KEMIJA TEKOČIN IN RAZTOPIN |
| **Course Title:** | PHYSICAL CHEMISTRY OF LIQUIDS AND SOLUTIONS |

| Študijski program in stopnja<br>Study Programme and Level | Študijska smer<br>Study Field | Letnik<br>Academic Year | Semester<br>Semester |
|---|---|---|---|
| **UŠP Kemija, 1. stopnja** | **/** | **3.** | **6.** |
| **USP Chemistry, 1st Cycle** | **/** | **3rd** | **6th** |

**Vrsta predmeta / Course Type:** izbirni strokovni / Elective Professional

**Univerzitetna koda predmeta / University Course Code:** KESI10

| Predavanja<br>Lectures | Seminar<br>Seminar | Vaje<br>Tutorial | Klinične vaje<br>Work | Druge oblike študija | Samost. delo<br>Individual Work | ECTS |
|---|---|---|---|---|---|---|
| **30** | **45** | **/** | **/** | **/** | **75** | **5** |

**Nosilec predmeta / Lecturer:** prof. dr. Marija Bešter Rogač / Dr. Marija Bešter Rogač, Full Professor
doc. dr. Bojan Šarac / Dr. Bojan Šarac, Assistant 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): |
|---|---|
| Tekočine: klasifikacija tekočin, medmolekulske sile, urejenost v tekočinah, enačbe stanja.<br>Osnovne fizikalne in kemijske lastnosti tekočin: molska masa in molski volumen, vrelišča in tališča.<br>Termodinamske lastnosti čistih tekočin: termodinamika faznih ravnotežij, enostavni fazni diagrami.<br>Tekoči kristali: urejenost in molekularna struktura v tekočih kristalih.<br>Polarne tekočine: dielektrične lastnosti, voda, strukturne lastnosti tekoče vode, nevodne polarne tekočine.<br>Nepolarne tekočine: klasifikacija, donorsko in akceptorsko število | The liquid state of matter: classes of liquids, order in liquids, equations of state. Basic physical and chemical properties of liquids: molar mass and molar volume, boiling and freezing points. Thermodynamic properties of pure liquids: thermodynamic of phase equilibria, single-component phase diagrams. Liquids crystals: order in liquid crystals, molecular structure in the mesophase. Polar liquids: dielectric properties, water, structural models of liquid water, non-aqueous polar solvents. Non-polar liquids: classification, donor and acceptor numbers. Solute-solvent interactions: electrostatic interaction, polarization, dispersion forces, repulsion |

| | |
|---|---|
| Klasifikacija interakcij topljenec-topilo: elektrostatske interakcije, polarizacija, disprezijske sile, odbojne interakcije, hidrofobne (»solvofobne«) interakcije.<br>Mešanice neelektrolitov: termodinamske lastnosti tekočih mešanic, idealne in neidealne mešanice, topnost, superkritično stanje.<br>Fazni diagrami večkomponentnih sistemov: fazno pravilo, ravnotežje tekočina–para v binarnih sistemih, ravnotežje trdno-tekoče v binarnih sistemih, ternarni sitemi, porazdelitveni koeficient.<br>Osnovni principi topnosti: parametri topnosti, Hansen-ovi parametri topnosti<br>Mešana topila: dielektrične lastnosti, viskoznost, vpliv mešanih topil na kemijsko ravotežje (selektivna solvatacija, asociacija ionov), donor-akceptor lastnosti<br>Ionske tekočine: struktura, klasifikacija, lastnosti, mešanice ionskih in neionskih tekočin, uporaba. | interactions, hydrophobic ("solvophobic") interactions. Mixtures of non-electrolytes: thermodynamic properties of liquid mixtures, ideal and non-ideal mixing, solubility, supercritical state. Phase diagrams for multicomponent systems: phase rule, vapour-liquid equilibrium with two components, liquid-solid equilibrium with two components, three-component liquids, partition coefficients. Basic solubility principles: solubility parameters, Hansen parameters. Mixed solvents: dielectric properties, viscosity, the effect of mixed solvents on the chemical equilibria (selective salvation, ion association), donor-acceptor properties.<br>Ionic liquids: structure, classification, properties, mixtures of ionic-and non-ionic liquids, application. |

**Temeljna literatura in viri / Readings:**

**Osnovna literatura:**

M. Bešter-Rogač, Zapiski predavanj, FKKT, 2018.

J.N. Murrell and A.D. Jenkins, Properties of Liquids and Solutions, 2nd Edition Wiley Interscience, 1997, 250 strani.

**Dodatna literatura:**

P. Atkins and J. de Paula, Physical Chemistry, 9th Edition, Oxford University Press, 2010, Chapter 17, pp 622-643.

C. Reichard and T. Welton, Solvents and Solvent Effects in Organic Chemistry, 4th Edition, Wiley-VCH, 2010, Chapters 2 and 3, pp. 7-99.

R. Hayes, G. G. Warr, R. Atkin, Structure and Nanostructure in Ionic Liquids, Chem. Rev., 2015, 115, 6357−6426.

| **Cilji in kompetence:** | **Objectives and Competences:** |
|---|---|
| Cilj predmeta je nadgradnja osnovnega znanja fizikalne kemije tekočin in raztopin.<br><br>Kompetence: Poudarjeno je poznavanje specifičnih lastnosti tekočin in raztopin, ki določajo tudi njihovo uporabo. | The objective of the course is to upgrade the basic knowledge of the physical chemistry of liquids and solutions.<br><br>Competencies: The knowledge of specific properties, which also determines their use, is emphasized. |

| **Predvideni študijski rezultati:** | **Intended Learning Outcomes:** |
|---|---|
| Znanje in razumevanje<br>Razumevanje lastnosti tekočin in raztopin na molekularnem nivoju ter povezava le-teh z makroskopskimi lastnostmi. | Knowledge and Comprehension<br>Understanding properties of liquids and solutions at both the thermodynamic and molecular level and connection to their macroscopic properties. |
| Uporaba<br>Večina reakcij (tudi v industrijskem merilu) poteka v tekočem mediju, biokemijski in naravni sistemi so povezani s tekočim stanjem. Predmet bo tako uporaben za različna področja (kemija, biokemija, farmacija, vede o materialih in okolju) pri obravnavi tekočin bodisi praktično v laboratoriju ali kot osnova za razumevanje. | Application<br>Ability to follow the current research in the field of liquids and solutions, to interpret the processes carried out in the liquid state (synthesis, separation) and to solve relevant problems in chemistry, biochemistry, pharmacy, environmental science. |
| Refleksija<br>Sposobnost razumevanja problematike in sposobnost kreativnega reševanja praktičnih problemov povezanih z tekočinami in raztopinami. | Analysis<br>Ability of understanding and creative solving of practical problems connected with liquids and solutions. |
| Prenosljive spretnosti<br>Spretnosti izbiranja in uporabe strategij, metod in interpretacije rezultatov povezanih z tekočinami in raztopinami na različnih področjih. | Skill-transference Ability<br>The ability of choosing and application of the strategies, methods and interpretation of data of liquids and solutions in different fields |

| **Metode poučevanja in učenja:** | **Learning and Teaching Methods:** |
|---|---|
| Predavanja, seminarji z reševanjem problemov, seminarske naloge | Lectures, seminars with solving of problems, seminar projects |

| **Načini ocenjevanja:** | Delež (v %) / Weight (in %) | **Assessment:** |
|---|---|---|
| - pisni izpit | **50%** | -written exam |
| - seminarska naloga | **50%** | -seminar project |
| ocene: pozitivno 6-10; negativno 1-5 | | marks: positive 6-10, negative 5 |

**Reference nosilca / Lecturer's references:**

1. TOMAŠ, Renato, TOT, Aleksandar, KUHAR, Jure, **BEŠTER-ROGAČ, Marija**. Interactions in aqueous solutions of imidazolium chloride ionic liquids [CnCnmim][Cl] (n=0, 1, 2, 4, 6, 8) from volumetric properties, viscosity B-coefficients and molecular dynamics simulations. Journal of molecular liquids,.. 2018, 254, 267-271.

2. ZEC, Nebojša, **BEŠTER-ROGAČ, Marija**, VRANEŠ, Milan, GADŽURIĆ, Slobodan. Volumetric and viscosimetric properties of [bmim][DCA] + γγ-butyrolactone binary mixtures. Journal of Chemical Thermodynamics, 2016, 97, 307-314.

3. **BEŠTER-ROGAČ, Marija**, FEDOTOVA, Marina V., KRUČININ, Sergej, KLÄHN, Marco. Mobility and association of ions in aqueous solutions : the case of imidazolium based ionic liquids. PCCP.

Physical chemistry chemical physics .2016, 18, 28594-28605.

4. **BEŠTER-ROGAČ, Marija**, STOPPA, Alexander, BUCHNER, Richard. Ion association of imidazolium ionic liquids in acetonitrile. The journal of physical chemistry. B, Condensed matter, materials, surfaces, interfaces & biophysical, , 2014, vol. 118, no. 5, str. 1426-1435

1. **ŠARAC, Bojan**, HADŽI, San. Analysis of protonation equilibria of amino acids in aqueous solutions using Microsoft Excel. J. Chem. Educ., 2021, 98, 1001-1007.

2. **ŠARAC, Bojan**, BEŠTER-ROGAČ, Marija. The influence of ionic liquids on micellization of sodium dodecyl sulfate in aqueous solutions. Acta Chim. Slov., 2020, 67, 977-984,

3. **ŠARAC, Bojan**, MEDOŠ, Žiga, COGNIGNI, Alice, BICA, Katharina, CHEN, Li-Jen, BEŠTER-ROGAČ, Marija. Thermodynamic study for micellization of imidazolium based surface active ionic liquids in water : effect of alkyl chain length and anions. Colloids Surfa. A, 2017, 532, 609-617.