UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	FIZIKALNA KEMIJA
Course Title:	PHYSICAL CHEMISTRY

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
UNI Biokemija, 1. stopnja	**/**	**2**	**3,4**
USP Biochemistry, 1st Cycle	**/**	**2nd**	**3rd,4th**

Vrsta predmeta / Course Type: Obvezni/mandatory

Univerzitetna koda predmeta / University Course Code:

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Work	Druge oblike študija	Samost. delo Individual Work	ECTS
80	**25**	**45 LV**	**/**	**/**	**150**	**10**

Nosilec predmeta / Lecturer: prof. dr. Ksenija Kogej / Dr. Ksenija Kogej, 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):**
Plini. Uvod. Lastnosti plinov. Enačbe stanja, idealni in realni plini. Kritični pojavi, utekočinjanje plinov. **Prvi zakon termodinamike.** Delo in toplota. Prvi termodinamični zakon. Notranja energija, entalpija. Toplotne kapacitete. Kalorimetrija. Diferenčna dinamična kalorimetrija. Termokemija. Odvisnost entalpije od temperature. **Drugi zakon termodinamike.** Obrnljivi in neobrnljivi procesi. Entropija. Računanje entropijskih sprememb pri reverzibilnih in ireverzibilnih procesih. Tretji termodinamični zakon. Gibbsova in Helmholtzova prosta energija. Odprti sistemi. Kemijski potencial in kriterij za snovno ravnotežje. Fazno pravilo.	**Gasses**. Properties of gasses. Equations of state, ideal and real gasses. Critical phenomena, condensation of gasses. **The first law of thermodynamics.** Work and heat. The internal energy and enthalpy. Heat capacities. Calorimetry. Differential scanning calorimetry. Thermochemistry. Dependence of enthalpy on temperature. **The second law of thermodynamics.** Reversible and irreversible processes. Entropy. Calculation of entropy changes in reversible and irreversible processes. The third law of thermodynamics. Gibbs and Helmholtz free energy. Open systems. Chemical potential and the criterion for equilibrium. The phase rule. Phase equilibria. The Clausius-Clapeyron equation.

Fazna ravnotežja. Clausius-Clapeyronova enačba. Fazni diagrami. **Raztopine.** Parcialne molske količine. Idealne in neidealne raztopine. Termodinamika mešanja. Raoultov in Henryjev zakon. Koligativne lastnosti. Raztopine elektrolitov. Ionske aktivnosti. Debye-Hückelov zakon. Vsoljevanje in izsoljevanje. Koligativne lastnosti raztopin elektrolitov. Donnanov efekt. Biološke membrane. **Kemijsko ravnotežje.** Termodinamična konstanta kemijskega ravnotežja. Ravnotežje v plinastem stanju. Heterogeno ravnotežje. Vpliv temperature in tlaka na ravnotežje. Vezanje ligandov na makromolekule. Disociacijska ravnotežja. **Elektrokemija.** Elektrokemijski členi. Napetost galvanskega člena. Termodinamika galvanskega člena. Biološka oksidacija. Membranski potencial. **Kemijska kinetika.** Hitrostni zakon, red reakcije in konstanta reakcijske hitrosti. Mehanizem reakcije. Razpolovni čas. Vzporedne, postopne in obojesmerne reakcije. Vpliv temperature na hitrost reakcije. Kataliza. Aktivacijska energija. Encimska kinetika in inhibicija. **Laboratorijske vaje:** Kalorimetrija. Parni tlak in izparilna entalpija. Krioskopija. Heterogeno ravnotežje. Napetost in notranja upornost galvanskih členov, merjenje pH. Termodinamika galvanskega člena. Prevodnost šibkih in močnih elektrolitov. Protolitsko ravnotežje. Kemijska kinetika.	Phase diagrams. **Solutions.** Partial molar quantities. Ideal and non-ideal solutions. Thermodynamics of mixing. Raoult's and Henry's law. Colligative properties. Electrolyte solutions. Ionic activities. Debye-Hückel theory. Salting-in and salting-out. Colligative properties of electrolytes. The Donnan effect. Biological membranes. **Chemical equilibrium.** Thermodynamic equilibrium constant. Equilibrium in gaseous systems. Heterogeneous equilibrium. Effect of temperature and pressure on equilibrium. Binding of ligands to macromolecules. Bioenergetics. Dissociation equilibria. **Electrochemistry**. Electrochemical cells. Electromotive force (EMF) of galvanic cell. Thermodynamics of galvanic cells. Biological oxidation. Membrane potential. **Chemical kinetics.** Reaction rates, reaction order and the rate constant. Reaction mechanism. The half-life. Reversible, consecutive and chain reactions. The effect of temperature on reaction rate. Catalysis. Activation energy. Enzyme kinetics and inhibition. **Laboratory practice:** Calorimetry. Vapour pressure and heat of vaporization. Cryoscopy. Heterogeneous equilibrium. EMF and internal resistance of galvanic cells, measurement of pH. Thermodynamics of galvanic cells. Conductivity of weak and strong electrolytes. Protolytic equilibrium. Chemical kinetics.

Temeljna literatura in viri / Readings:

Temeljna literatura:

Raymond Chang: Physical Chemistry for the Biosciences, University Science Books, Sausalito, California, 2005; 190 strani (50 %).

P. W. Atkins: Physical Chemistry, 7th Edition, Oxford University Press, Oxford, 2002, 400 strani (38 %).

Matjaž Bončina, Janez Cerar, Andrej Godec, Barbara Hribar Lee, Andrej Jamnik, Jurij Lah, Andrej Lajovic, Miha Lukšič, Črtomir Podlipnik, Iztok Prislan, Jurij Reščič, Bojan Šarac, Matija Tomšič in Gorazd Vesnaver: FIZIKALNA KEMIJA – PRAKTIKUM, interno študijsko gradivo, Ljubljana, 2011, 260 strani (40 %).

Dopolnilna literatura:

P. Atkins and J. de Paula: Physical Chemistry for the Life Sciences, Oxford University Press, Oxford, UK, 2006.
W. J. Moore: Physical Chemistry, 5th Edition, Harlow: Longman, 1996; 950 strani.

Cilji in kompetence:

Fizikalna kemija je osnovni naravoslovni predmet, pri katerem študenti spoznajo temeljne fizikalno-kemijske zakonitosti in njihovo uporabo pri reševanju zelo različnih problemov iz naravoslovja. Predmet usmerja študenta k samostojnemu delu ter k abstraktnemu in kritičnemu razmišljanju o svojih opažanjih. Osvojeno znanje mu pomaga razumeti in interpretirati pojave v naravi ter jih povezovati z drugimi naravoslovnimi vedami, še posebej s temami iz biokemije. Eden od pomembnih cilje je, da študenti preverijo razumevanje pridobljenega teoretičnega znanja v laboratoriju, kjer se spoznajo z meritvami pomembnih fizikalnih zakonitosti in lastnosti snovi.

Objectives and Competences:

Physical chemistry is a fundamental natural science course where students learn about basic physical-chemical principles and their application in solving various problems in chemistry and nature. The aim is to direct student to independent work and to critical and abstract thinking about their observations. The acquired knowledge helps students to understand and interpret phenomena in nature and to relate them with other natural sciences, in particular with subjects related to biochemistry. One of important objectives is that students verify their understanding of theoretical knowledge of physical-chemical principles in laboratory by measuring various physical properties of matter.

Predvideni študijski rezultati:

Znanje in razumevanje

Študent se pri predmetu spozna z osnovnimi naravnimi zakonitosti sistemov in fizikalno kemijskih količin. Osvoji osnovne termodinamske zakone, pojme obrnljivi in neobrnljivi procesi ter spozna kriterije za spontanost procesov in za ravnotežje. Spozna razliko med termodinamiko in kinetiko ter osvoji pristope za obravnavo preprostih in bolj zapletenih reakcijskih mehanizmov, npr. encimske kinetike. Nauči se razmišljati v okviru različnih enostavnih modelov. Osnovne termodinamične zakonitosti se nauči uporabljati na primerih iz biokemijskega področja. Pri študiju predmeta študent razvije kritičen in analitičen način razmišljanja, ki je nujen za razumevanje kompleksnih pojavov na področju biokemije. Velik poudarek predmeta je tudi na laboratorijskih vajah, katerih cilj je pridobivanje spretnosti za izvajanje meritev termodinamičnih in kinetičnih količin. Študent se nauči pravilnega in kvalitetnega izvajanja meritev in ustreznega podajanja rezultatov, ki jih interpretira v skladu s teoretičnim znanjem,

Intended Learning Outcomes:

Knowledge and Comprehension

Students learn to understand basic natural principles for various systems and physical and chemical quantities. They are acquainted with basic thermodynamic laws, with concepts reversible and irreversible processes, with criteria for spontaneity and equilibrium. Students learn to understand the difference between thermodynamics and kinetics and acquire the principles for treating simple and more complex reaction mechanisms, e.g. enzyme kinetics. They acquire critical thinking in the framework of simple models and learn to apply basic thermodynamic principles to solving problems in biochemistry. They develop a critical and analytical way of thinking necessary for understanding complex phenomena in the field of biochemistry. Emphasis of the course is also on laboratory practice where students learn about how to measure thermodynamic and kinetic quantities. They are taught how to correctly and precisely perform measurements and report their results. They interpret the results in frames of theories which they learned

ki ga je osvojil pri predavanjih.	in courses.
Uporaba Študij predmeta Fizikalna kemija je nujna podlaga za to, da bo študent razumel principe raziskovalnih metod, ki jih bo uporabljal na različnih strokovnih področjih, saj moderne eksperimentalne tehnike v veliki meri temeljijo na fizikalno-kemijskih procesih. Pridobljeno znanje mu bo pomagalo pri interpretaciji dobljenih rezultatov in pri razumevanju pojavov na biokemijskem in drugih področjih. Študent bo osvojil tudi veščine, ki so potrebne za kvalitetno izvajanje meritev fizikalno-kemijskih količin. Spretnosti in izkušnje, ki jih bo pridobil pri delu v laboratoriju, mu bodo koristile pri nadaljnjem strokovnem razvoju in pri vključevanje v delo v večjih interdisciplinarnih raziskovalnih skupinah in v industrijskih družbah. S tem se bo naučil posredovati znanje in rezultate drugim.	Application The course in Physical Chemistry is the necessary basis for understanding fundamentals of research methods that are used in various fields, because modern experimental techniques are based on physical and chemical processes treated within this subject. The knowledge of physical chemistry helps students to interpret phenomena in biochemistry and in other fields. Students will gain skills necessary to correctly perform measurements of physical-chemical properties. The skills and experience they acquire in team work in laboratory will be useful in their future professional work, in particular in larger interdisciplinary research groups or in teams in companies. In this way they learn how to transfer knowledge among group members.
Refleksija Študent pridobi občutek za fizikalno-kemijski način razmišljanja, razvije zmožnost abstraktne predstave o fizikalno-kemijskih količinah in se naučil povezovanja znanja. To mu omogoča interpretacijo pojavov v naravi, reševanje praktičnih problemov na raznih področjih in odločanje o smiselnosti uporabe spoznanih teorij v praksi.	Analysis Students acquire the physicochemical way of thinking, develop abstract conceptions of physical-chemical properties, and learn to correlate the knowledge. This enables them to interpret phenomena in nature, to solve practical problems in various fields, and to critically assess the use appropriate theories in practice.
Prenosljive spretnosti Študent se nauči uporabljati domačo in tujo literaturo, privadi se varnega dela v laboratoriju, dela z raznimi aparaturami ter zbiranja, obdelovanja in interpretiranja rezultatov. Nauči se uporabljati računalnik tako za obdelavo kot za prikaz rezultatov in podajati pregledna in eksaktna poročila o opravljenem delu. Predmet študenta navaja tako na timsko kot tudi na samostojno delo.	Skill-transference Ability Students learn to use Slovene and English (international) literature, get trained in safe work in laboratory with various apparatuses, and learn to collect, treat, and interpret results. They learn to use the computer for calculations and graphical presentation of results and to clearly and exactly write reports of their work. Students learn to work in laboratory, both in teams and independently.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Predavanja, seminarji, laboratorijske vaje.	Lectures, seminars, practical course.

Delež (v %) /

Načini ocenjevanja:	Weight (in %)	**Assessment:**
Pisni izpit, ki ga lahko nadomestijo trije pozitivno ocenjeni pistni testi med letom. Pozitivno ocenjen kolokvij pri vajah. Ocene: pozitivno 6-10; negativno 1-5.	70 % 30 %	Written examination. The written part can be passed by 3 written tests during the year. Written exam from laboratory practice with a positive grade. Grades: positive 6-10; negative 1-5.

Reference nosilca / Lecturer's references:

-PRELESNIK, Simona, ASEYEV, Vladimir, **KOGEJ, Ksenija**. Differences in association behavior of isotactic and atactic poly(methacrylic acid). Polymer, ISSN 0032-3861. [Print ed.], 2014, vol. 55, no. 3, str. 848-854, [COBISS.SI-ID 1675823]

-ANKO, Maja, MAJHENC, Janja, **KOGEJ, Ksenija**, SILLARD, Rannard, LANGEL, Ülo, ANDERLUH, Gregor, ZORKO, Matjaž. Influence of stearyl and trifluoromethylquinoline modifications of the cell penetrating peptide TP10 on its interaction with a lipid membrane. Biochimica et biophysica acta, Biomembranes, ISSN 0005-2736. [Print ed.], 2012, vol. 1818, iss. 3, str. 915-924, ilustr. [COBISS.SI-ID 4881434]

-**KOGEJ, Ksenija**. Association and structure formation in oppositely charged polyelectrolyte-surfactant mixtures. Advances in colloid and interface science, ISSN 0001-8686. [Print ed.], 2010, vol. 158, no. 1/2, str. 68-83, [COBISS.SI-ID 34100741]