UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	ANORGANSKA KEMIJA
Course Title:	INORGANIC CHEMISTRY

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
UŠP Kemijsko inženirstvo, 1. stopnja, UŠP Biokemija, 1. stopnja, UŠP Kemija, 1. stopnja	**/**	**1.**	**2.**
USP Chemical Engineering, 1st Cycle, USP Biochemistry, 1st Cycle, USP Chemistry, 1st Cycle	**/**	**1st**	**2nd**

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: KE108

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

Nosilec predmeta / Lecturer: prof. dr. Anton Meden / Dr. Anton Meden, 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):
Periodni sistem kot osnova sistematike elementov in anorganskih spojin. **Vodik in kisik.** Voda. Vodikov peroksid. Protolitske reakcije oksidnega peroksidnega in superoksidnega iona. Nomenklatura. **Elementi 17. skupine**. Spojine elementov 17. skupine z vodikom. Spojine s kisikom, oksokisline in oksosoli. Medhalogenske spojine. Reakcije disproporcionacije in vpliv sinteznih pogojev na kemijsko ravnotežje pri pripravi oksospojin halogenov. Nomenklatura.	**Periodic table** as a basis of the systematic of elements and inorganic compounds. **Hydrogen, Oxygen**, Water, Hydrogen peroxide. Protolytic reactions of oxide, peroxide and superoxide ion, Nomenclature. **Elements of Group 17**. Compounds of Group 17 elements with hydrogen. Compounds with oxygen, oxo-acids and oxo-salts. Interhalogen compounds. Disproportionation reactions and the influence of synthesis conditions on the

Elementi 16. skupine. Spojine elementov 16. skupine z vodikom. Protoliza sulfidnih ionov. Oksidi in oksospojine žvepla, selena in telurja. Primeri homogene in heterogene katalize pri sintezi žveplove kisline. Spojine s halogeni. Nomenklatura.

Elementi 15. skupine. Spojine elementov 15. skupine z vodikom. Sinteza amoniaka: vpliv reakcijskih pogojev in katalizatorja na ravnotežje in hitrost reakcije. Oksidi in oksospojine. Spojine elementov V. skupine s halogeni in žveplom. Nomenklatura.

Elementi 14. skupine. Spojine elementov 14. skupine z vodikom. Oksidi, oksospojine in soli. Boudouardovo ravnotežje. Halogenidi in sulfidi elementov 14. skupine. Ogljikov dioksid v vodni raztopini: kombinacija molekularne in protolitske reakcije. Silikati. Nomenklatura.

Elementi 13. skupine. Bor in spojine bora. Razlaga strukture boranov z uporabo kombinacije teorije VV in MO. Aluminij in spojine aluminija. Pregled lastnosti spojin galija, indija in talija. Nomenklatura.

Elementi 1. in 2. skupine. Lastnosti zemeljskoalkalijskih kovin in njihovih spojin. Lastnosti alkalijskih kovin in njihovih spojin. Nomenklatura.

Elementi 18. skupine. Spojine žlahtnih plinov in njihove lastnosti.

Pregled kemije prehodnih elementov. d-orbitale in njihova vloga v kemiji prehodnih elementov. Pregled lastnosti prve vrste kovin prehoda. Pregled lastnosti druge in tretje vrste kovin prehoda. Lantanoidi in aktinoidi. Jedrske reakcije. Pregled elementov in njihovih spojin po skupinah. Oksidi, hidroksidi in oksokisline prehodnih elementov. Koordinacijske spojine in njihova uporaba.

preparations of oxo-compounds of halogens. Nomenclature.

Elements of Group 16. Compounds of Group 16 elements with hydrogen. Protolysis of sulfide ions. Oxides and oxo-compounds of sulfur, selenium and tellurium. Examples of homogeneous and heterogeneous catalysis at the synthesis of sulfuric acid. Compounds with halogens. Nomenclature.

Elements of Group 15. Compounds of Group 15 elements with hydrogen. Synthesis of ammonia: the influence of reaction conditions and catalyst on the equilibrium and velocity of reaction. Oxides and oxo-compounds. Compounds of group 15 elements with halogens and sulfur. Nomenclature.

Elements of Group 14. Compounds of Group 14 elements with hydrogen. Oxides oxo-compounds and salts. Influence of reaction conditions on the equilibrium of CO and CO_2. Halogenides and sulfides of the Group 14 elements. Carbonic acid in aqueous solution: combination of protolytic and molecular compounds. Silicates. Nomenclature.

Elements of Group 13. Boron and boron compounds. Explanation of the structures of boranes applying a combination of VB and MO theories. Aluminum and aluminum compounds. Survey of the properties of gallium, indium and thallium compounds. Nomenclature.

Elements of Groups 1 and 2. Properties of earth-alkali metals and their compounds. Properties of alkali metals and their compounds. Nomenclature.

Elements of Group 18. Compounds of noble gases and their properties.

Survey of the chemistry of transition elements. d-orbitals and their role in the transition elements chemistry. Survey of the properties of the first row of transition elements. Survey of the properties of the second and third row of transition elements. Lanthanoids and actinoids. Nuclear reactions. Survey of the groups of transition elements. Oxides, hydroxides and

	oxo-acids of the transition elements. Coordination compounds and their application.

Temeljna literatura in viri / Readings:

Osnovni učbenik:

- F. Lazarini, J. Brenčič: Splošna in anorganska kemija, Visokošolski učbenik Založba FKKT, Ljubljana, 2004, str. 262-521.

Dodatna literatura:

- C. E. Housecroft, A. G. Sharpe, Inorganic Chemistry, Pearson, Prentice Hall, 2nd, 2005; (http://files.rushim.ru/books/neorganika/housecroft.pdf) (40%)

Cilji in kompetence:	**Objectives and Competences:**
Cilji: Študenti usvojijo temeljno in celostno znanje anorganske kemije, poznavanje določenih anorganskih spojin, njihovih lastnosti in reaktivnosti. Pri tem študent na specifičnih primerih utrjuje in poglablja znanje splošnih kemijskih zakonitosti. **Kompetence:** Študent bo pridobljeno znanje znal uporabiti pri nadaljnjem študiju in v praksi, znal se bo pogovarjati o kemijskih problemih s področja, ki ga obravnava predmet; znal bo povezati znanje splošne in anorganske kemije za reševanje, razlago ali analizo določenega problema. Poznal bo strukturne značilnosti in reaktivnost anorganskih spojin, značilne in pomembne kemijske reakcije anorganskih spojin ter nomenklaturo anorganskih spojin	**Objectives: s**tudents acquire basic and complete knowledge of inorganic chemistry, knowledge of given inorganic compounds, their properties and reactivity. Along with this, the student confirms ad deepens the knowledge of general chemical principles. **Competences:** student will be able to apply the acquired knowledge at further study and in practice, he will be able to discuss chemical problems in the field of the subject and will be able to integrate the knowledge of general and inorganic chemistry to solve, explain or analyze a given problem. He will know the structural characteristics and reactivity of inorganic compounds and the nomenclature thereof.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
Znanje in razumevanje Študent pozna osnovne značilnosti kemije elementov glavnih skupin in prehodnih elementov v periodnem sistemu ter pozna in razume osnovne kemijske zakonitosti , ki vplivajo na periodične lastnosti elementov in njihovih spojin (strukturne značilnosti,	Knowledge and Comprehension Student knows basic chemical characteristics of the main group elements and transition elements in the periodic system. He knows and understands the basic chemical principles that influence the periodic properties of the elements and their compounds (structural

reaktivnost anorganskih spojin, značilne in pomembne kemijske reakcije anorganskih spojin ter nomenklaturo anorganskih spojin).	properties, reactivity of inorganic compounds, characteristic and important chemical reactions of the inorganic compounds and nomenclature of the inorganic compounds).
Uporaba Pridobljeno znanje in razumevanje so potrebna osnovna znanja, ki jih študent uporablja za razlago eksperimentalno določenih ali drugače pridobljenih podatkov, povezanih s kemijo elementov glavnih skupin in prehodnih elementov periodnega sistema in je osnova za nadaljnji študij kemije. Prav tako je to znanje temeljno pri opravljanju poklica	Application Acquired knowledge and understanding are the necessary basis that is applied for explanation of experimental or otherwise acquired data, connected to the chemistry of the main group elements and the transition elements of the periodic system, which is the basis of the further study of chemistry. This knowledge is as well fundamental for the professional activity.
Refleksija Študent je sposoben oceniti pomen osnovnih kemijskih zakonitosti in teoretskega znanja za razlago eksperimentalnih dejstev in lastnosti anorganskih snovi in jih zna uporabiti v praksi.	Analysis Student is able to asses the meaning of basic chemical principles and theoretical knowledge for an explanation of experimental facts and properties of compounds and is able to use them in practice.
Prenosljive spretnosti Študent zna poiskati podatke iz strokovne literature, podatke iz virov medmrežja pa zna kritično oceniti. Zna uporabljati strokovni jezik (pisno in ustno).	Skill-transference Ability Student is able to find data from professional literature and is able to critically evaluate the data from the internet; he is able to use the professional language (written and spoken).

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Predavanja; sodelovalno učenje/ poučevanje ter problemsko delo na seminarjih. Sprotno preverjanje znanja s testi.	Lectures; cooperative learning/teaching and problem work at seminars; regular knowledge assessment using tests.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
2 testa za sprotno preverjanje znanja in pisni izpit. Če študent na vsakem od obeh testov najmanj 51 % točk je lahko oproščen opravljanja izpita. Ocenjevalna lestvica v skladu z enotno lestvico na Univerzi v Ljubljani: 6 – 10 opravil izpit, 1 – 5 ni opravil izpita.		2 test for during the semester and written exam. If the student collects at least 51 % of points at each of the tests, he can be excused from the exam. Grades according to the standard levels of the University of Ljubljana: 6-10 passed, 1-5 insufficient.

Reference nosilca / Lecturer's references:

- MALI, Gregor, **MEDEN, Anton**, DOMINKO, Robert. [sup] 6 Li MAS NMR spectroscopy and first-principles calculations as a combined tool for the investigation of Li [sub] 2 MnSiO [sub] 4 polymorphs. *Chemical communications*, ISSN 1359-7345, 2010, issue 19, str.3306-8, doi: 10.1039/c003065a. [COBISS.SI-ID 4386074]

- KÜZMA, Mirjana, DOMINKO, Robert, HANŽEL, Darko, KODRE, Alojz, ARČON, Iztok, **MEDEN, Anton**, GABERŠČEK, Miran. Detailed in situ investigation of the electrochemical processes in Li[sub]2FeTiO[sub]4 cathodes. *Journal of the Electrochemical Society*, ISSN 0013-4651, 2009, vol. 156, no. 10, str. A809-A816. [COBISS.SI-ID 4219162]
- MOLČANOV, Krešimir, KOJIĆ-PRODIĆ, Biserka, **MEDEN, Anton**. [pi]-Stacking of quinoid rings in crystals of alkali diaqua hydrogen chloranilates. *CrystEngComm*, ISSN 1466-8033, 2009, vol. 11, iss. 7, str. 1407-1415, doi: 10.1039/b821011j. [COBISS.SI-ID 516331545]

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	BIOTEHNOLOGIJA
Course Title:	BIOTECHNOLOGY

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
UŠP Kemijsko inženirstvo, 1. stopnja	**/**	**2.**	**4.**
USP Chemical Egineering, 1st Cycle	**/**	**2nd**	**4th**

Vrsta predmeta / Course Type: izbirni strokovni / Elective Professional

Univerzitetna koda predmeta / University Course Code: INSI1

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Work	Druge oblike študija	Samost. delo Individual Work	ECTS
45	**15**	**15 LV**	**/**	**/**	**75**	**5**

Nosilec predmeta / Lecturer: izr. prof. dr. Polona Žnidaršič Plazl / Dr. Polona Žnidaršič Plazl, Associate 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):
Biotehnologija, njena struktura in interdisciplinarnost. Osnove biotehnologije – osnove mikrobiologije in mikrobne tehnologije. Osnove industrijske mikrobiologije. Osnove genetskega spreminjanja organizmov. Osnove biokatalitskih procesov in bioremediacije. Od mikroorganizma do produkta. Osnove pripravljalnih, produkcijskih in zaključnih procesov. Struktura laboratorijskega, pilotnega in industrijskega procesa. Biotehnološki procesi – Biotehnologija antibiotikov, organskih kislin, aminokislin, imunostimulantov, industrijskih encimov, biogoriva, biotehnologija vina in piva,	Biotechnology its structure and interdisciplinarity. Basic aspects of biotechnology. Basic aspects of microbiology and microbial technology. Basic aspects of industrial microbiology. Basic aspects of genetic engineering. Basic aspects of biocatalysis and bioremediation.From the microorganism to the final product. Basic aspects of *up-stream*, production and *down stream* processing. The structure of laboratory, pilot and industrial process. Biotechnology processes – biotechnology of aerobic processes : antibiotics, organic and amino acids, imunostimulants, industrial enzymes, biofuels. Biotechnology of anaerobic

ekonomika bioprocesov. Bioetika v biotehnologiji.	processes : wine and beer technology. Economics of bioprocessing. Bioetics in biotechnology.

Temeljna literatura in viri / Readings:

- Mitchell, DA, Krieger, N, Berovič, M. Solid-State Fermentation Bioreactors : Fundamentals of Design and Operation. Berlin, Springer, 2006, 442 str. (30%)
- Ratledge C., Kristiansen B., Basic Biotechnology, Cambridge Press, (2001), 342 str. (30%)
- Ignacimurthu S., Biotechnology, Alpha Science Inter. Ltd., Oxford Press (2008), 362. str (20%)
- Enfors S-O., Häggström L.,Bioprocess technology, KTH Press (1996), 356 str. (20%)

Cilji in kompetence:	**Objectives and Competences:**
Cilj predmeta je spoznavanje študentov z interdisciplinarnostjo in zakonitostimi biotehnologije in vloge, mikrobiologije, biokemije in biokemijskega inženirstva v biotehnologiji. Predmet se povezuje s kemijskim inženirstvom, fizikalno kemijo, industrijsko mikrobiologijo, rastlinsko in animalno biotehnologijo. Študentje si pri predmetu pridobijo naslednje specifične kompetence: - sposobnost razumevanja vloge in možnosti aplikaciji inženirskih znanj v biotehnologiji - sposobnost povezovanja inženirskih znanj z znanji mikrobiologije, biokemije, genetike in genskega inženiringa - sposobnost razumevanja delovanja in vloge in mikroorganizmov v biotehnoloških procesih - sposobnost razumevanja strukture delovanja biotehnološkega procesa od laboratorijskih raziskav do industrijskega postopka - Sposobnost razumevanja vloge pripravljalnih procesov, produkcijskih in zaključnih procesov v biotehnologiji	The aim of this course is to introduce students the interdisciplinary and legality of biotechnology in the sence of its applications, microbiology, biochemistry and biochemical engineering. The focus of the study is to learn how to use engineering technology skills and application in laboratory and industrial practice. The course is linked to chemical engineering, physical chemistry, industrial microbiology, plant and animal biotechnology - Capability and insight in the strathegy and the role of bioreactor design according to the type of microorganism or tissue culture, type of bioprocess and the mode of operation. - Capability and interlinking of bioreactor operation and techniques with chemical and biochemical engineering principles – mass and heat transport processes, fluid dynamics, process rheology and the modes of operation. - Capability of understading the influence of microbial physiology to the bioreactor design and the modes of operation and their influence to the bioprocess development and design. - Capability of understading of pilot and larged scale bioreactors operation.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**

Znanje in razumevanje Študentje spoznajo strukturo in interdisciplinarnost področja biotehnologije. Pridobijo osnovna znanja mikrobiologije in mikrobne fiziologije, potrebna za razumevanje poročja in spoznajo pomen in vlogo inženirstva v biotehnoloških postopkih.	Knowledge and Comprehension Students learn about the structure and interdisciplinary field of biotechnology. Acquire basic knowledge of microbiology and microbial physiology needed to understand the area and learn about the importance and role of engineering aspects in biotechnological processes.
Uporaba Študent uporabi znanja in razumevanja o mehanizmih in vlogi mikroorganizmov v biosintezi različnih produktov visokotonažne, rekombinantne in fine biotehnologije, ki jih v praksi nadgradi z inženirskimi znanji.	Application Student use of knowledge and understanding the mechanisms and the role of microorganisms in the biosynthesis of various bulk, recombinant and fine biotechnology products, that in practice upgrade with the engineering skills.
Refleksija Študentje so sposobni samostojno sklepati, definirati problem, kritičnega ovrednotenja skladnosti med teoretičnimi načeli in praktičnim ravnanjem, postavljati zaključke in reševati nekatere zanimive probleme v biotehnologiji.	Analysis Students are able to conclude independently, define a problem, to make a critical evaluation of conformity between theoretical principles and practical behavior, and to formulate independent conclusions and solve some actual biotechnology problems.
Prenosljive spretnosti Študentje pridobijo sposobnost identificiranja in reševanja tehnoloških problemov, sposobni so zbiranja in interpretacije podatkov, kritične analize in sinteze pridobljenih znanj v tehnoloških študijah, povezovanja znanj iz strokovne literature s prakso in prenosom pridobljenih znanj v sorodne tehnologije. Znanje v obliki predavanj, seminarjev in teoretičnih znanj in znanja iz znanstvene literature.	Skill-transference Ability Students gain the ability to identify and solve technological problems, they are capable of collecting and interpreting data, critical analysis and synthesis of acquired knowledge in technological studies, integration of knowledge from the scientific literature with the practice and transmission of the acquired knowledge in related technologies. Knowledge in the form of lectures, seminars and theoretical skills and knowledge from the scientific literature.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Predavanja, seminarji in praktične vaje, strokovne ekskurzije v industriji.	Lectures, seminars, exercises

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**

Pisni in ustni izpit Opravljene vaje so pogoj za pristop k izpitu.	**70%** **30%**	Written and oral exam Accomplished laboratory practice is prerequisite to exam attendance

Reference nosilca / Lecturer's references:

- Wohlgemuth, R., Plazl, I., **Žnidaršič Plazl, P**., Gernaey, K.V., Woodley, J.M. Microscale technology and biocatalytic processes: opportunities and challenges for synthesis. Trends Biotechnol., 2015, 33: 302-314.
- Cvjetko, M., Vorkapić-Furač, J., **Žnidaršič Plazl, P**. Isoamyl acetate synthesis in imidazolium-based ionic liquids using packed bed enzyme microreactor. Process Biochem., 2012, 47: 1344-1350.
- **Žnidaršič Plazl, P**., Plazl, I. Microbioreactors. V: Moo-Young, M. (ur.). Comprehensive Biotechnology, 2nd Ed. Amsterdam [etc.]: Elsevier, 2011, str. 289-301

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	DIPLOMSKO DELO
Course Title:	DIPLOMA WORK

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
UŠP Kemijsko inženirstvo, 1. stopnja	**/**	**3.**	**6.**
USP Chemical Egineering, 1st Cycle	**/**	**3rd**	**6th**

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: D1KI

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Work	Druge oblike študija	Samost. delo Individual Work	ECTS
/	**/**	**/**	**/**	**225**	**225**	**15**

Nosilec predmeta / Lecturer:

Jeziki / Languages:

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites:**
Odobrena tema diplomskega dela.	Approved topic.

Vsebina:	**Content (Syllabus outline):**
Diplomsko delo se opravlja iz področja kemijskega inženirstva. Vsebina in naslov se določata v soglasju z izbranim mentorjem. Mentor je lahko učitelj na UL FKKT [t.j. zaposleni na fakulteti na učiteljskem delovnem mestu ali zaposleni na fakulteti na delovnem mestu asistenta, ki ima učiteljski naziv (docent, izredni ali redni profesor) ali nosilec predmeta na študijskem programu 1. ali 2. stopnje UL FKKT, ki ni zaposlen na fakulteti]. Mentor je praviloma učitelj na programu, ki ga je študent vpisal.	Diploma work is performed in one of the areas of chemical engineering. The contents and the title are agreed upon with the mentor. Mentor is a teacher at UL FKKT or employed at assistant position with habilitation of Assistant Professor, Associate Profesor or Full Professor. Mentor is also a teacher who lectures at 1st or 2nd cycle of studies at UL FKKT. Mentor should teach at the programme where student is involved.

Temeljna literatura in viri / Readings:

Monografije in članki, ki so povezani z dogovorjeno tematiko diplomskega dela.

Books and journal articles related to the research topic.

Cilji in kompetence:	**Objectives and Competences:**
Dokončno oblikovanje pričakovanega lika diplomanta. Študent bodo ob izdelavi diplomske naloge pokazal sposobnosti iskanja in zaznavanja problemov kemijskega inženirstva in znal poiskati rešitev za tak problem. Pri delu bodo pokazal, da je pridobil večino kompetenc navedenih v programu študija.	Final formation of the competences of a diploma's degree candidate. Through carrying out research for the diplom's thesis student should be able to demonstrate the skills for autonomous identification of a problem related to chemival engineering and finding solutions, thus proving that specific competences from the programme have been acquired.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
Znanje in razumevanje Pri izdelavi diplomskega dela bo slušatelj pridobil: • sposobnosti formuliranja problema, • sposobnosti samostojnega iskanja ustrezne literature, • sposobnosti obravnavanja problema v praksi, • sposobnosti iskanja rešitev in utemeljevanja ustreznosti rešitev, sposobnosti predstavitve rezultatov svojega dela.	Knowledge and Comprehension Through carrying out research for the diploma's thesis student will develop skills for formulating the problem and he will be able for independent literature review. He will develop ability to solve actual problems and he will be able to confirm his decisions and solutions. He will develop skills for presentation of his work.
Uporaba Znanje in pridobljene veščine bo diplomant lahko uporabil pri opravljanju poklica.	Application Student with diploma will be able to use acquired knowledge in his professional carrier as chemical engineer.
Refleksija Povezovanje vseh pridobljenih teoretičnih znanj z reševanjem problemov na področju kemijskega inženirstva ter kritični pogled na uporabnost teh znanj.	Analysis Connection of all acquired theoretical knowledge to solve problems in the chemical engineering area. Critical distance to acquired knowledge.
Prenosljive spretnosti Pri delu bo diplomant pridobil znanja o metodah reševanja problemov, o načinu prezentacije teh znanj v pisani in govorjeni obliki povezani z ostalimi metodami posredovanja raziskav ugotovitev itd.	Skill-transference Ability Research for the diplom's thesis will help the student to gain knowledge on problem solving methodologies, how to present acquired knowledge as well as results in writen in oral form.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Individualno delo mentorja in samostojno študijsko in raziskovalno delo.	Individual work with mentor and independent self-study and research work.

Delež (v %) /

Načini ocenjevanja:	Weight (in %)	**Assessment:**
Ocenjuje se diplomsko delo in zagovor diplomskega dela pred komisijo, ki jo sestavljajo predsednik, mentor in en član.		Diploma work and its presentation are graded separately by a three-member commission (chairman, mentor, additional member).

Reference nosilca / Lecturer's references:

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UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	FIZIKA
Course Title:	PHYSICS

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
UŠP Kemijsko inženirstvo, 1. stopnja, UŠP Biokemija, 1. stopnja, UŠP Kemija, 1. stopnja	**/**	**1.**	**1. in 2.**
USP Chemical Engineering, 1st Cycle, USP Biochemistry, 1st Cycle, USP Chemistry, 1st Cycle	**/**	**1.**	**1st and 2nd**

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
90	/	**60 SV**	/	/	**150**	**10**

Nosilec predmeta / Lecturer: prof. dr. Svjetlana Fajfer / Dr. Svjetlana Fajfer, Full Professor
prof. dr. Janez Bonča / Dr. Janez Bonča, Full Professor
prof. dr. Igor Muševič / Dr. Igor Muševič, 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):
Kinematika: premo enakomerno in pospešeno gibanje točkastega telesa, gibanje v prostoru. **Dinamika:** sila in masa. Newtonovi zakoni, izrek o gibanju težišča, izrek o gibalni količini, sila curka, izrek o kinetični energiji, delo, potencialna energija, prožnost, prožnostna energija, vrtenje togega telesa okoli nepremične osi, navor, Newtonov zakon pri vrtenju, izrek o vrtilni količini. **Mehanika tekočin:** hidrostatika, hidrostatični	**Kinematics:** uniform and accelerated motion of a particle, motion in space **Dynamics:** Force and mass; Chord force; Newton's laws; the theorem on the system of particles and velocity of the centre of mass; kinetic energy theorem; work; potential energy; elasticity; rotation of a rigid body around a fixed axis; torque; Newton's law on rotation; theorem on conservation of angular momentum.

tlak, vzgon, hidrodinamika, opis toka tekočin, Bernoullijeva enačba.
Nihanje in valovanje: amplituda, frekvenca in nihajni čas, sinusno nihanje, nihanja molekul, vsiljeno nihanje, sklopljeno nihanje, spekter nihanja, longitudinalno in transferzalno valovanje, energijski tok, gostota energijskega toka, valovna dolžina, hitrost valovanja, interferenca, stoječe valovanje, spekter valovanja, lastna nihanja, osnove akustike.
Električno polje in električni tok: Coulombov zakon, statično električno polje, električno polje točkastega naboja, električno polje v okolici električnega dipola, električni potencial, napetost, Gaussov zakon, Poissonova enačba, kondenzator, kapaciteta kondenzatorja, dielektrik v elektricnem polju, izoliran prevodnik v električnem polju, influenca, Ohmov zakon, enosmerni in izmenični tok, izmenični tok skozi ohmski upor in kondenzator, merjenje električnega toka in napetosti, električno delo in moč.
Magnetno polje: statično magnetno polje, gostota magnetnega polja, sila na vodnik v magnetnem polju, magnetni navor na tokovno zanko, magnetni moment, bio-magnetna orientacija (preko kristalov magnetita), Amperov zakon, magnetno polje v okolici ravnega vodnika, v tuljavi, induktivnost tuljave, izmenični tok skozi tuljavo, indukcija, električni nihajni krog, dušeno nihanje.
Svetloba: nastanek elektromagnetnega valovanja, hitrost elektromagnetnega valovanja, odboj, lorn in interferenca svetlobe, svetlobni energijski tok, absorpcija svetlobe, fotometrija, spekter svetlobe, elektromagnetno sevanje segretih teles (Wiennov in Stefanov zakon).
Geometrijska optika: zrcala in leče enačba zrcal in leč, oko, napake očes, optične naprave: povečevalno steklo in mikroskop.
Izbrana poglavja iz moderne fizike: fotoefekt, uklonska slika curka elektronov, de Broglijeva valovna dolžina, Bohrov model atoma

Fluid mechanics: hydrostatics, hydrostatic pressure; buoyancy; hydrodynamics; description of fluid flow; Bernoulli's equation.
Oscillation and wave motions: amplitude, frequency and oscillation intervals; harmonic oscillation; oscillation of molecules, forced oscillation; oscillation of coupled oscillators; oscillation spectrum; longitudinal and transversal waves, radiant flux, radiant flux density, wave length; the speed of a travelling wave, interference, standing waves; motion spectrum; fundamentals of acoustics.
Electric field and electric current: Coulomb's law, static electric field; electric field of a point charge, electric field of an electric dipole, electric potential, voltage, Gauss's law, Poisson's equation, capacitor, capacitance, dielectric in electric field, insulated conductor in electric field, influence, Ohm's law, direct and alternating current, alternating current through Ohm's resistor and capacitor, measuring electric current and voltage, electrical work and power.
Magnetic field: static magnetic field, density of magnetic field, magnetic force on a current-carrying conductor, magnetic torque on a current loop, magnetic moment, bio-magnetic orientation (via magnetite crystals), Amper's law, magnetic field in the vicinity of a long straight wire, in the coil, inductivity of a coil, alternating current through a coil, induction, alternating current in an undamped and damped electric circuit.
Light: formation of electromagnetic radiation, speed of electromagnetic radiation, reflection, refraction and interference, radiant energy, absorption of light, photometry, light spectrum, electromagnetic radiation of black bodies (Wienn's and Stefan's law).
Geometrical optics: reflectors and lenses, equation of mirrors and lenses, eye, vision corrections, optical devices, magnifying glass and microscope.
Selected topics in modern physics: photo effect, electron beam diffraction, de Broglie's wave length, Bohr's model of atom.

Temeljna literatura in viri / Readings:

Osnovna/Basic:

- J.Strnad: Fizika II, DZS, Ljubljana, 1977. pp. 288, (50%)
- R.Kladnik: Visokošolska fizika II, DZS, Ljubljana, 1989. pp. 335 (30%)

Dodatna/Additional:

- D. Halliday, R. Resnick, J. Walker: Fundamentals of Physics (Extended), John Wiley, New York, 1993.
- R. A. Serway in J. S. Faughn, College Physics, Saunders College Publishing, 1999.

Cilji in kompetence:	**Objectives and Competences:**
Predmet je podlaga za pridobitev kompetenc s področja priprave materiala za preiskave in izvajanje nadzora kakovosti kar vključuje umerjanje analizatorjev, izvajanje kontrole kvalitete dela in sodelovanje pri kontroli kvalitete rezultatov.	The course represents the basis to reach competences in the area of material preparation for research and quality control that is composed of instrument calibration, work quality control and cooperation in controlling the reliability of results.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
Znanje in razumevanje Pri predmetu Fizika študenti pridobijo razumevanje osnovnih fizikalnih pojmov in fizikalnih količin, spoznajo osnovne zakone narave ter se ob reševanju problemov navadijo osnov analitičnega mišljenja.	Knowledge and Comprehension During the physics course students obtain the understanding of basic physical concepts and quantities, they obtain the understanding of the basic laws of nature and through problem solving acquire the basics principles of analytical thinking.
Uporaba Dobro poznavanje osnovnih fizikalnih zakonitosti olajša študentu delo s sodobno laboratorijsko opremo, mu omogoča poglobljeno razumevanje njenega delovanja in tako poveča učinkovitost njene uporabe pri vsakdanjem delu. Fizikalno znanje je tudi nujno potrebno pri izvajanju, obdelavi in kritičnem ovrednotenju dobljenih meritev, kar predstavlja osnovo laboratorijskega dela. Predmet Fizika se neposredno navezuje na predmete: Fizikalna kemija,	Application In depth understanding of basic physics laws empowers the student to operate modern laboratory equipment and enables better understanding the quality of measurements. This in turn increases the efficiency of operating the equipment. Physical knowledge is as well crucial in critical analysis of results that represent the basis of laboratory work. Physics connects to the following classes: Physical chemistry
Refleksija Pridobljeno znanje fizikalnih osnov bo študentu omogočilo kritično ovrednotiti rezultate laboratorijskih meritev in poglobljeno razumevanje predpisanih postopkov pri izvajanju meritev.	Analysis The acquired knowledge of physics will enable the student to critically evaluate the outcomes of laboratory measurements and rigorous understanding of prescribed measurement procedures.

Prenosljive spretnosti Sposobnost samostojnega spremljanja novih spoznanj in literature s področja laboratorijske tehnike. Razumevanje fizikalnih meritev in sposobnost njihovega ovrednotenja. Kritičen odnos do standardov kakovosti.	Skill-transference Ability The ability to autonomously follow the latest advances in the field of modern laboratory techniques. Understanding of physical measurements and the ability of critical evaluation of quality standards and procedures.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Predavanja s prikazom fizikalnih eksperimentov. Računske vaje.	Lectures with demonstration of physical experiments. Problem solving.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni izpit iz računskih vaj. Končna ocean je sestavljena iz		Written exam problem solving. Final score:
-izpita iz teorije	**50 %**	theory: 50%,
-izpita iz vaj	**50 %**	problem solving: 50%.
Ocene 6-10 pozitivno.		Grades 6-10 positive results.

Reference nosilca / Lecturer's references:

Prof. dr. Svjetlana Fajfer / Dr. Svjetlana Fajfer, Full Professor

1. Svjetlana Fajfer, Jernej F. Kamenik, Ivan Nisandzic, Jure Zupan “Implications of Lepton Flavor Universality Violations in B Decays”, Phys.Rev.Lett. 109 (2012) 161801.

2. Ilja Doršner, **Svjetlana Fajfer**, Nejc Košnik, Ivan Nišandžić “Minimally flavored colored scalar in bar B ->D (*) tau bar nu and the mass matrices constraints”, JHEP 1311 (2013) 084.

3. Ilja Dorsner, **Svjetlana Fajfer**, Admir Greljo, Jernej F. Kamenik “Higgs Uncovering Light Scalar Remnants of High Scale Matter Unification”, JHEP 1211 (2012) 130.

4. Jure Drobnak, **Svjetlana Fajfer**, Jernej F. Kamenik “Probing anomalous tWb interactions with rare B decays”, Nucl.Phys. B855 (2012) 82-99.

5. Ilja Dorsner, **Svjetlana Fajfer**, Jernej F. Kamenik, Nejc Kosnik “Light colored scalars from grand unification and the forward-backward asymmetry in t t-bar production”, Phys.Rev. D81 (2010) 055009.

Prof. dr. Janez Bonča / Dr. Janez Bonča, Full Professor

1. VIDMAR, Lev, **BONCA, Janez**, TOHYAMA, Takami, and MAEKAWA, Sadamichi, Quantum Dynamics of a Driven Correlated System Coupled to Phonons, Phys. Rev. Lett. 107, 246404-1-246404-4 (2011).

2. MIERZEJEWSKI, Marcin, **BONČA, Janez**, PRELOVŠEK, Peter. Integrable Mott insulators driven by a finite electric field. Phys. Rev. Lett., 107, 126601-1-126601-4, (2011).

3. MIERZEJEWSKI, Marcin, VIDMAR, Lev, **BONČA, Janez**, PRELOVŠEK, Peter. Nonequilibrium quantum dynamics of a charge carrier doped into a Mott insulator. Phys. Rev. Lett. 106, 196401-1-196401-4 (2011).

4. VIDMAR, Lev, **BONČA, Ja**nez, MIERZEJEWSKI, Marcin, PRELOVŠEK, Peter, TRUGMAN, Stuart A. Nonequilibrium dynamics of the Holstein polaron driven by an external electric field. Phys. Rev., B 83, 134301-1-134301-7 (2011).

5. VIDMAR, Lev, **BONČA, Janez**, MAEKAWA, Sadamichi, TOHYAMA, Takami. Bipolaron in the t-J model coupled to longitudinal and transverse quantum lattice vibrations. *Phys. Rev. Lett.* 103, 186401 (2009).
6. BONČA, Janez, MAEKAWA, Sadamichi, TOHYAMA, T. Numerical approach to the low-doping regime of the t-J model. *Phys. Rev. B* 76, 035121 (2007).

Prof. dr. Igor Muševič / Dr. Igor Muševič, Full Professor

1. I. Muševič, Izpitna vprašanja iz fizike za kemike, (Zbirka izbranih poglavij iz fizike, 36). Ljubljana: DMFA - založništvo, 2002. 9 str. ISBN 961-212-126-5.
2. M. Vilfan, **I. Muševič**, Tekoči kristali, (Knjižnica Sigma, 74). Ljubljana: DMFA - založništvo, 2002. 117 str., ilustr. ISBN 961-212-136-2.
3. I. Muševič, M. Škarabot, U. Tkalec, M. Ravnik, S. Žumer, Two-dimensional nematic colloidal crystals self-assembled by topological defects. *Science* 313, 954-958 (2006).
4. U. Tkalec, M. Ravnik, S. Čopar, S. Žumer, **I. Muševič**, Reconfigurable knots and links in chiral nematic colloids. *Science* 333, 62 (2011).
5. I. Muševič, S. Žumer, Maximizing memory. *Nature Materials* 10, 1 (2011).

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	INSTRUMENTALNE METODE ANALIZE
Course Title:	INSTRUMENTAL METHODS OF ANALYSIS

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
UŠP Kemijsko inženirstvo, 1. stopnja	**/**	**2.**	**3.**
USP Chemical Egineering, 1st Cycle	**/**	**2nd**	**3rd**

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: IN115

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

Nosilec predmeta / Lecturer: izr. prof. dr. Matevž Pompe / Dr. Matevž Pompe, Associate Professor

Jeziki / Languages: **Predavanja / Lectures:** **slovenski / Slovenian**; **Vaje / Tutorial:** **/**

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):
Osnovni pojmi in parametri analiznega procesa: izbira metode, priprava vzorca, občutljivost, selektivnost, meja zaznave. **Statistika in vrednotenje rezultatov**: naključne in sistematične napake, statistični parametri in obdelava podatkov, ovrednotenje rezultatov, načrtovanje ekperimetov. **Ravtotežja v analizni kemiji** **Pregled analiznih metod za določanje makro komponent.** Prednosti in slabosti teh metod. **Pregled instrumentalnih metod za identifikacijo in kvantitativno določanje snovi**. Interakcija elektromagnetnega valovanja s snovjo. Principi tehnik in uporabnost za	**Basic concepts and parameters of the analytical process:** choice of methods, sample preparation, sensitivity, selectivity, detection limit. **Statistics and evaluation of the results:** random and systematic errors, statistical parameters and data processing, evaluation of the results, experimental design. **Equilibrium in analytical chemistry** **Overview of the analytical methods for determination of macro components:** advantages and disadvantages of the methods. **Overview of the instrumental methods for the identification and quantification of substances.**

analitiko. Molekulska absorpcijska spektrometrija: osnovne zakonitosti, značilnosti in uporaba. Atomska absorpcijska in emisijska spektrometrija: osnovni principi, karakteristike metod in značilne uporabe v analitiki anorganskih spojin. IR spektrometrija, značilnosti, priprava vzorcev za merjenje. Rentgenska fluorescenca: princip in uporaba **Elektrokemijske metode.** Potenciometrija, principi, indikatorske in referenčne elektrode, steklena elektoda in merjenje pH, uporaba za potenciometrično indikacijo pri različnih titracijah. Elektrogravimetrija, voltametrija. Kontinuirno spremljanje koncentracij snovi. **Uporaba predstavljenih metod za kvantitativno določanje komponent v realnih vzorcih.** Priprava vzorcev, raztapljanje, shranjevanje. **Separacijske metode**. Ekstrakcija tekoče-tekoče. Ekstrakcija na trdno fazo. Osnove kromatografije. Plinska in tekočinska kromatografija. Zmožnosti metod in uporaba za določanje organskih snovi v realnih vzorcih. Masna spektrometrija. Osnove ionizacije. Tipi analizatorjev. Uporaba MS za identifikacijo in kvantifikacijo. ICPMS in uporaba. Izbira metode in kritično ovrednotenje rezultatov analiz. Osnove validacije. NMR osnove in uporabnost.	The interaction of electromagnetic radiation with matter. Principles of the techniques and application in analytical chemistry. Molecular absorption spectrometry: basic principles, characteristics and applications. Atomic absorption and emission spectrometry: basic principles, method characteristics and applications in analysis of inorganic matter. IR spectrometry, characteristics, sample preparation. X-ray fluorescence spectrometry: principles and applications. **Electrochemical methods.** Potentiometry, principles, indicator and reference electrodes, glass electrode and measurements of pH, application in various potentiometric titrations. Electrogravimetry, voltammetry. Continuous monitoring of the concentration of the substance. **The use of the presented methods for the determination of components in real samples.** Sample preparation, dissolution, storage. **Separation methods.** Liquid-liquid extraction. Solid-phase extraction. Basic principle of chromatography. Gas and liquid chromatography. The ability of the methods and the usage for the determination of the organic compounds in the real samples. Mass spectrometry. Basics of the ionisation. Mass analyzers. Application of MS for identification and quantification. ICP/MS and usage Selection of the methods and critical evaluation of the analytical results. Basics of the method validation. Basics and applications of NMR.

Temeljna literatura in viri / Readings:

- D.A.Skoog, F.J.Holler, T.A.Nieman, Principles of Instrumental analysis, 5th Saunders College Publishing, 1998,Philadelphia, str. 700 (45%)

Cilji in kompetence:	**Objectives and Competences:**
Slušatelji v okviru predmeta osvojijo temeljne principe kemijske analize. Pridobijo znanja potrebna za razumevanje in izvedbo posameznih kemijskih in osnovnih instrumentalnih tehnik. Spoznajo pristope k izvedbi analiz. Specifične kompetence: zmožnost izbire posamezne analizne metode za reševanje enostavnih analiznih problemov.	Student in this course acquire basic knowledge of chemical analysis. Gains knowledge needed to understand and implement individual basic chemical and instrumental techniques. Learns about the approaches of the analyses. Specific skills: ability to choose specific analytical methods for solving simple analytical problems.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
Znanje in razumevanje Študentje spoznajo instrumentalne metode in primernost njihove uporabe za reševanje konkretnih analiznih problemov. Znajo kritično uporabiti rezultate.	Knowledge and Comprehension Students learn instrumental methods and their application to solving specific analytical problems. Student gain knowledge for critical evaluation of the results.
Uporaba Študent je sposoben izbrati analizno metodo za rešitev problema. Razume dobljene rezultate.	Application Students are capable of selection of analytical method for solving particular analytical problem. Students understand obtained results.
Refleksija Spozna prednosti in slabosti različnih instrumentalnih metod in jih zna kritično izbrati.	Analysis Students learn advantages and disadvantages of various instrumental methods and are capable of their critical selection.
Prenosljive spretnosti Študent bo poznal in razumel podatke, dobljene z instrumentalnimi metodami	Skill-transference Ability Students will know and understand the data obtained by instrumental methods.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Predavanja	Lectures

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni (nadomestita ga lahko dva pozitivno ocenjena kolokvija) in ustni izpit.		Written (can be substituted by two positively graded colloquium) and oral exam.

Reference nosilca / Lecturer's references:

1. S. Kose, S. Koral, B. Tufan, **M. Pompe**, A. Ščavničar, D. Kočar. Biogenic amine contents of commercially processed traditional fish products originating from European countries and Turkey. European Food Research and Technology. A, Zeitschrift für Lebensmittel-Untersuchung und -Forschung. 2012, 235, 669-683.
2. G. Arh, L. Klasinc, M. Veber, **M. Pompe**. Calibration of mass selective detector in non-target analysis of volatile organic compounds in the air. J. chromatogr. A 2011, 1218, 1538-1543.
3. J. Cerar, **M. Pompe**, M. Guček, J. Cerkovnik, J. Škerjanc. Analysis of sample of highly water-soluble T[sub]-symmetric fullerenehexamalonic acid C[sub](66)(COOH)[sub](12) by ion-chromatography and capillary electrophoresis. J. chromatogr. A 2007, 1169, 86-94.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	KEMIJSKA IN PROCESNA VARNOST
Course Title:	CHEMICAL AND PROCESS SAFETY

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
UŠP Kemijsko inženirstvo, 1. stopnja	**/**	**2.**	**4.**
USP Chemical Egineering, 1st Cycle	**/**	**2nd**	**4th**

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: IN118

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Work	Druge oblike študija	Samost. delo Individual Work	ECTS
45	**15**	**15 LV**	**/**	**/**	**75**	**5**

Nosilec predmeta / Lecturer: doc. dr. Barbara Novosel / Dr. Barbara Novosel, 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):
Prepoznavanje, razumevanje delovanja in obvladovanje nevarnih kemikalij (eksplozivne, vnetljive, oksidativne, strupene, jedke in okolju nevarne kemikalije ter plini). Pregled evropskega sistema obvladovanja tveganja pri ravnanju s kemikalijami - REACH. Varnost pri delu v laboratoriju, kemijskih in drugih procesnih industrijah. Kompleksnost delovanja industrijskega procesa, tehnološki režim in standardni proizvodni postopki, ustreznega vzdrževanja posameznih naprav in celotnega sistema. Ocena verjetnost za nastanek izrednih situacij v kemijskih procesih ter preprečevanje in ukrepanje.	Knowledge on recognition, understanding and management of hazardous chemicals (explosive, flammable, oxidizing, toxic, corrosive and environmentally hazardous chemicals and gases). Fundamentals of European system of risk management in handling the chemicals - REACH. Safety, Health and Loss Prevention at work in a laboratory, chemical and other process industries. The complexity of the operation of industrial processes, technological regime and the standard manufacturing procedures, proper maintenance of individual devices and the entire system. Estimate the probability of accidents in chemical processes, prevention and response.

Identifikacija potencialnih nevarnosti v kemijskem procesu, začetni dogodki, širjenje izrednih dogodkov, zmanjševanje posledic izrednih dogodkov. Analiza industrijskih procesov in priprava ocen tveganja. Zajemanje pomembnih in kritičnih parametrov ter pogojev procesa, ki vplivajo na njegovo varnost, možni scenariji izrednih dogodkov. Kvalitativna in kvantitativna ocena tveganja. Vaje: seznanjanje z možnim tveganjem v kemijskem procesu (podatki o nevarnih kemikalijah, vnetljive trdne snovi), določevanje snovnih lastnosti snovi (plamenišče, tališče), prašne eksplozije (določevanje minimalne vžigne energije), plini (nevarnosti, preprečevanje, označevanje tlačnih posod), možnosti in načini preprečevanja nastanka izrednih razmer.	Identification of of potential risks in the chemical process, initiating events, the spread of incidents, reducing the consequences of exceptional events. Analysis of industrial processes and the preparation of risk assessments. Capture important and critical process parameters and conditions that affect the security of the possible scenarios of emergencies. Qualitative and quantitative risk assessment. Exercises: Students get knowledge of the risk in chemical process (information about hazardous chemicals, flammable solids), determination of material properties (flash point, melting point), dust explosion (determination of minimum ignition energy), gas (hazard prevention, identification of pressure vessels), possibilities and ways of preventing the occurrence of an emergency.

Temeljna literatura in viri / Readings:

- Burke R.: Hazardous materials chemistry for emergency responders, 2nd Ed.Boca Raton, Lewis 2002 (97-373).
- Brauer, R., L.: Safety and health for engineers, 2nd Ed., Wiley-Interscience, Hoboken, 2006 (93 – 336, 629-722)
- Marshall V., Ruhemann S., Fundamentals of Process Safety, ICHEME, Warwickshire 2001 (20%)
- Crowl D.A., Louvar J.F., Chemical Process Safety, 2nd Ed., Prentice Hall PTR, New Jersey 2002 (20%)

Cilji in kompetence:	**Objectives and Competences:**
Pri predmetu se študenti seznanijo z zagotavljanjem varnosti pri delu z različnimi kemikalijami v laboratoriju in v kemijskih ter procesnih industrijah. Spoznajo potrebo po natančnem poznavanju vseh lastnosti kemikalij, ki jih pri svojem delu uporabljajo. Pridobljeno znanje omogoča razumevanje in presojanje nevarnosti oziroma stopnje tveganja ter določitev ukrepov za varno in zdravo delo. Študentje spoznajo, da je za varno delo v industriji osnovni pogoj natančno poznavanje vseh faz procesa in podrobna analiza delovanja na osnovi katere se izvede ocene tveganja. Spoznajo, da je varnost procesa pogojena z mnogo dejavniki in da je za njegovo varno obratovanje potrebno tako	Students get knowledge to ensuring safety, health and loss prevention in chemical processes. Learn about the need of precise knowledge of the characteristics of chemicals they use at work. The knowledge enables the students to understand and assess the level of danger or risk and to establish measures to ensure the safe handling of hazardous chemicals. Students learn that basic conditions for safe work in industry are exact knowledge of all phases of the process and the importance of a risk assessment. Students learn that process safety depends on many factors. For safe operation is necessary so optimize the performance of individual part of the process operation as well as the system as a whole.

optimalno delovanje posameznih procesnih operacij kot tudi usklajeno delovanje sistema kot celote. Študentje se pri predmetu usposobijo za sistematičen pregled kemijskih in drugih sorodnih procesov, zaznavanje potencialnih kritičnih mest, priprave ocene tveganja in ukrepov za zmanjšanje tveganja.	Students are trained for a systematic review of chemical and other related processes, identify potential critical points, preparation of risk assessment and risk reduction measures.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
Znanje in razumevanje Študentje se pri predmetu usposobijo za sistematičen pregled nevarnosti pri uporabi nevarnih kemikalij ter pri delu v kemijskih in sorodnih procesih, za zaznavanje potencialnih kritičnih mest, pripravo ocene tveganja in ukrepov za zmanjšanje tveganja.	Knowledge and Comprehension The subject makes students capable of a systematic review of the risks of using dangerous chemicals and work in the chemical and related processes for detecting potential critical points, risk assessment and risk reduction measures.
Uporaba Delo z nevarnimi kemikalijami. Vodenje in nadzor kemijskih procesov. Ocenjevanje tveganja kemijskih procesov. Analiza nazgod in določevanje ukrepov za preprečitev nezgod.	Application Work with hazardous chemicals. Management and control of chemical processes. Risk assessment of chemical processes. Accident analysis and determination of measures to prevent accidents.
Refleksija Študenta se usmeri v podrobnejši pregled lastnosti posamezne kemikalije z namenom, da ugotovi nevarnosti snovi za človeka in okolje. Na osnovi spoznanj mora določiti varnostne ukrepe za zmanjšanje ali celo eliminacijo tveganja pri rabi kemikalije. Glede na veljavno SI zakonodajo so podana znanja osnova za opravljanje izpita za svetovalce za kemikalije v različnih podjetjih, kakor tudi temelji za delo v carinski, komercialni ali inšpektorski službi.	Analysis A student will be directed to a more detailed examination of the properties of each chemical in order to identify the hazards of the substance for humans and the environment. Based on the findings should establish the security measures for the reduction or even elimination of risk in the use of chemicals. According to the current SI legislation knowledge is the basis for the exam for counselors of chemicals in various companies, as well as it is basis for the job of customs, commerce or in the field of inspections.
Prenosljive spretnosti Sistematičen, analitičen pristop do reševanja problema, več razumevanja in upoštevanja varnostne kulture.	Skill-transference Ability Systematic, analytical approach to problem solving, more understanding and taking into account safety culture.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
- Predavanja, - seminarji, - praktične vaje	- lectures, - Seminars, - Practical exercises

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**

Pisni izpit. 50% Ustni izpit. 50%	**50 %** **50 %**	Written exam Oral exam

Reference nosilca / Lecturer's references:

- SLABAJNA, Dominika, **NOVOSEL, Barbara**. Smernica za zagotavljanje varnosti in zdravja v kemijskih laboratorijih : projekt Kemijska varnost 3. Ljubljana: Urad RS za kemikalije: Univ. v Ljubljani, Fak. za kemijo in kemijsko tehnologijo, 2010. 48 str., ilustr. http://www.fkkt.uni-lj.si/si/?2416. [COBISS.SI-ID 34765317]
- **NOVOSEL, Barbara**, MARINŠEK, Marjan. Računska obravnava kemijskih procesov : zbirka nalog. V Ljubljani: Fakulteta za kemijo in kemijsko tehnologijo, 2003. 132 str., ilustr. ISBN 961-6286-56-0. [COBISS.SI-ID 125977600]

NOVOSEL, Barbara. Ugotavljanje kritičnih mest v kemijski industriji in zmanjševanje tveganja nezgod. V: BRVAR, Miran (ur.). Kemijske nesreče na delovnem mestu : zbornik prispevkov. Ljubljana: Slovensko zdravniško društvo, Sekcija za klinično toksikologijo, 2013, str. 78-83. [COBISS.SI-ID 1654319]

- MAČEK, Jadran, **NOVOSEL, Barbara**, MARINŠEK, Marjan. Anorganska kemijska tehnologija, Navodila za vaje za 3. letnik UN ŠP Kemijsko inženirstvo. Ljubljana: Fakulteta za kemijo in kemijsko tehnologijo, Katedra za anorg. kem. tehnologijo in materiale, 2001/2002. III, 61 str., tabele. [COBISS.SI-ID 24156165]

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	KEMIJSKA TERMODINAMIKA
Course Title:	CHEMICAL THERMODYNAMICS

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
UŠP Kemijsko inženirstvo, 1. stopnja	**/**	**2.**	**3.**
USP Chemical Egineering, 1st Cycle	**/**	**2nd**	**3rd**

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: IN114

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Work	Druge oblike študija	Samost. delo Individual Work	ECTS
60	**15**	**/**	**/**	**/**	**75**	**5**

Nosilec predmeta / Lecturer: prof. dr. Jurij Lah / Dr. Jurij Lah, Full Professor

Jeziki / Languages:

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

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):
Osnovni pojmi Sistem, lastnosti sistema, stanje sistema, funkcije stanja in funkcije poti, ravnotežje. Enačbe stanja: Plinski zakoni, enačba stanja idealnega plina, van der Waalsova enačba, virialna enačba, enačba stanja za plinske zmesi. Kritični pojavi. **Zakoni termodinamike** *I. zakon termodinamike:* Energija, toplota, delo. Reverzibilni in ireverzibilni procesi. Entalpija. Termokemija in termokemijske enačbe. *II. zakon termodinamike:* Toplotni stroji: izkoristek, Carnotov krožni proces. Entropija. Spremembe entropije pri reverzibilnih in	**Basic concepts** System and its properties, system state, state functions and path functions, equilibrium. Equations of state: Gas laws, equation of state for ideal gas, van der Waals equation, virial equation, equation of state for gas mixtures. Critical phenomena. **Laws of thermodynamics** I. Law of thermodynamics: energy, heat, work. Reversible and irreversible processes. Enthalpy. Thermochemistry and thermochemical equations. II. Law of Thermodynamics: Heat engines: efficiency, Carnot cycle. Entropy. Changes in

ireverzibilnih procesih. Ravnotežni pogoji za zaprte sisteme: prosta energija, termodinamski potenciali, odvisnost termodinamskih funkcij od tlaka in temperature. III. zakon termodinamike. **Odprti sistemi** Faze, komponente, prostostne stopnje. Fazno pravilo. Clapeyronova in Clausius-Clapeyronova enačba. Fazni diagrami. **Raztopine** Idealne in neidealne raztopine, Raoultov zakon, Henryjev zakon. Parcialne molske količine, kemijski potencial. Fugativnost, aktivnost in koeficient aktivnosti. Standardna stanja. Termodinamika mešanja. Koligativne lastnosti: Osmozni tlak, znižanje zmrzišča, zvišanje vrelišča. **Kemijsko ravnotežje** Konstanta ravnotežja. Homogeno ravnotežje v plinasti in tekoči fazi. Heterogena ravnotežja. Le Chatelierov princip.	entropy in reversible and irreversible processes. Equilibrium conditions for closed systems: free energy, thermodynamic potentials, the dependence of thermodynamic functions on pressure and temperature. III. Law of thermodynamics. **Open systems** Phase, components, degrees of freedom. Phase rule. Clapeyron and Clausius-Clapeyron equation. Phase diagrams. **Solutions** Ideal and non-ideal solutions, Raoult's law , Henry's law. Partial molar quantities, chemical potential. Fugacity, activity and activity coefficient. Standard states. Thermodynamics of mixing. Colligative properties: osmotic pressure, lowering the freezing point, boiling point increase. **Chemical equilibrium** Equilibrium constant. Homogeneous equilibrium in gaseous and liquid phase. Heterogeneous equilibria. Le Chatelier principle

Temeljna literatura in viri / Readings:

- A. Jamnik, Fizikalna kemija (1. izdaja), založba FKKT (2013) (80%), ISBN: 978-961-6756-39-6 (1. zvezek) (20%), ISBN: 978-961-6756-40-2 (2. zvezek).
- Physical Chemistry, P. Atkins in J. de Paula, Oxford University Press, 8. Izdaja (2006), 1050 str., (30%), ISBN 9780198700722.
- Physical Chemistry, W. Moore, Prentice-Hall, New Jersey, 5. Izdaja (1972), str. 1-570, (50%), ISBN 0582442346.

Cilji in kompetence:	**Objectives and Competences:**
Cilj predmeta je spoznavanje povezave med fizikalnimi in kemijskimi pojavi ter med fizikalnimi in kemijskimi lastnostmi snovi. Študent se seznani s temeljnimi fizikalno kemijskimi količinami, s katerimi popisujemo stanje sistemov, ter s povezavo med njimi. Spozna splošne zakonitosti pri opisu različnih problemov iz naravoslovja in fizikalno-matematične metode za njihovo reševanje.	The objective of this subject is to study the relation between physical and chemical phenomena and between physical and chemical properties of the matter. Students get acquainted with the fundamental physico-chemical quantities with which we describe the state of the systems, and the relation between them. Students learn about general laws useful in describing various problems in science and get acquainted with physico-mathematical

Študenti si pri predmetu pridobijo naslednje specifične kompetence: - razumevanje termodinamskih zakonov in termodinamskih funkcij stanja ter njihova uporaba pri kemijskih reakcijah in fizikalnih procesih - uporaba kriterijev za napoved spontanosti poljubnih procesov pri različnih konstantnih pogojih - uporaba različnih načinov, s katerimi vplivamo na kemijsko ravnotežje - sistematičnost pristopa pri reševanju teorijskih problemov in računskih nalog	methods to solve them. Students of the course gain the following specific competencies: - Understanding the thermodynamic laws and thermodynamic state functions and their use in chemical reactions and physical processes - Use of criteria for predicting the spontaneity of processes at different constant conditions - Use various ways for influencing the chemical equilibrium. - A systematic approach in solving theoretical and numerical problems.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
Znanje in razumevanje Poznavanje osnovnih fizikalno-kemijskih količin kot so notranja energija, entalpija, prosta energija in entropija. Poznavanje osnovnih zakonov termodinamike. Razumevanje pojmov obrnljivosti (reverzibilnosti) in neobrnljivosti (ireverzibilnosti) procesov. Poznavanje kriterijev za spontanost poteka kemijskih reakcij ter za kemijsko ravnotežje. Razumevanje razlike med termodinamiko (spontanostjo poteka) ter kinetiko (hitrostjo poteka) kemijske reakcije.	Knowledge and Comprehension Knowledge of basic physico-chemical quantities such as internal energy, enthalpy, free energy and entropy. Knowledge of the basic laws of thermodynamics. Understanding the concepts of reversible and irreversible processes. Knowing the criteria for spontaneous chemical reactions and chemical equilibrium. Understanding the difference between thermodynamics (spontaneity) and kinetics (rate) of a chemical reaction.
Uporaba Uporaba tabeliranih fizikalno-kemijskih podatkov (standardne tvorbene entalpije, standardne entropije, toplote faznih prehodov, toplotne kapacitete) pri določanju termodinamike kemijskih reakcij pri različnih pogojih.	Application Using tabulated physico-chemical data (standard enthalpy of formation, standard entropy, heat of phase transitions, heat capacity) in determining the thermodynamics of chemical reactions under different conditions.
Refleksija Pridobitev občutka za fizikalno-matematični način razmišljanja ter spoznanja o splošnih fizikalno-matematičnih metodah za reševanje različnih praktičnih problemov iz naravoslovja. Globlje razumevanje pomena abstraktnih fizikalno-kemijskih pojmov in količin. Kritična presoja pri izbiri kemijske reakcije za pridobivanje določenega produkta.	Analysis The students acquire the feeling for physico-mathematical way of thinking and for cognition about general physico-mathematical methods for the solution of various problems in natural science. Deeper understanding of the significance of abstract physico-chemical principles and properties. A critical assessment of the choice of chemical reactions for the production of a specific product.

Prenosljive spretnosti Uporaba splošnih naravoslovnih zakonitosti pri študiju inženirskih vsebin, ki so zajete pri drugih predmetih. Uporaba domače in tuje literature.	Skill-transference Ability The use of general natural laws in studying chemical engineering, which are included in other subjects. The use of domestic and foreign literature.

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

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni izpit.		Written exam.

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* 2000, 104, 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* 2001, 105, 1670-1687.
- DROBNAK, Igor, VESNAVER, Gorazd, LAH, Jurij. Model-based thermodynamic analysis of reversible unfolding processes. *J. Phys. Chem., B* 2010, 114, 8713-8722.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	KEMIJSKO INŽENIRSKA TERMODINAMIKA
Course Title:	CHEMICAL ENGINEERING THERMODYNAMICS

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
UŠP Kemijsko inženirstvo, 1. stopnja	**/**	**3.**	**5.**
USP Chemical Egineering, 1st Cycle	**/**	**3rd**	**5th**

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: IN132

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Work	Druge oblike študija	Samost. delo Individual Work	ECTS
60	**15**	**/**	**/**	**/**	**75**	**5**

Nosilec predmeta / Lecturer: doc. dr. Aleš Podgornik / Dr. Aleš Podgornik, Assistant Professor

Jeziki / Languages: **Predavanja / Lectures:** **slovenski / Slovenian**; **Vaje / Tutorial:** **/**

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):
Uvod: Pomen kemijsko inženirske termodinamike v praksi kemijskega inženirstva, tako na področju separacijskih procesov, načrtovanja reaktorjev, področju produktnega inženirstva, kot tudi uporabi termodinamike pri reševanju varnostnih in okoljskih problemov. Ocena in napoved termofizikalnih lastnosti realnih substanc: a) čistih komponent: gostota, viskoznost, parni tlak, toplotna kapaciteta, izparilna entalpija, toplotna prevodnost, površinska napetost; b) mešanic.	The significance of chemical engineering thermodynamics in the area of separation processes, design of reactors, product engineering, as well as the use of thermodynamics in solving safety and environmental problems. Estimation of thermo-physical characteristics of substances: pure components (density, viscosity, partial pressure, heat capacity, heat of evaporation, thermal conductivity, surface tension) and mixtures. Knowledge of phase equilibrium (two-phase, multi-phase and multi-component): VLE, GLE, SLE, chemical equilibrium, combined chemical and phase equilibrium; modern computational

Fazna ravnotežja (dvofazna, večfazna in večkomponentna): VLE, GLE, SLE, kemijsko ravnotežje, kombinirano kemijsko in fazno ravnotežje; Moderne računske metode: korelacijski modeli kot g^E modeli oz. modeli aktivnostnih koeficientov, enačbe stanja za realne snovne sisteme in napovedni modeli kot metode prispevkov grup (UNIFAC, PSRK,..), modeli za izbor ustreznega topila, teoretični modeli. Procesni simulatorji. Predstavitev nekaj eksperimentalnih metod za določanje termofizikalnih lastnosti čistih substanc in mešanic. Praktični in računski primeri ravnotežij. Procesna termodinamika: Zakon o ohranitvi mase, energije in entropijska bilanca. Obravnavanje procesov in naprav, ki omogočijo pretvorbo energije iz ene oblike v drugo: turbina, toplotni stroji, kompresorji, toplotne črpalke, hladilni stroji. Izračun stopnje učinkovitosti. Pseudo-krožni procesi. Uporaba toplotnih črpalk v kemijski industriji. Uporaba p,h-diagramov in t,s-diagramov, primerjava realnega sistema (nekaj realnih primerov) z idealnim procesom, analiza, ocena stopnje učinkovitosti. Termodinamski uščip. Ovrednotenje procesnih alternativ.	methods: correlation models, g^E models, models of activity coefficients, state equations for real systems, models for the selection of appropriate solvents, theoretical models; Process simulators; Practical and computational examples of equilibrium. Process thermodynamics comprises mass, energy and entropy balances. Processes and equipment for transformation of one energy form into another are discussed such as turbines, heat pumps, compressors, refrigeration systems. Calculation of efficiency. Application of heat balances in chemical industry. Usage of p,h-diagrams and t,s-diagrams, comparison of ideal and real processes, analysis, estimation of efficiency. Evaluation of process alternatives.

Temeljna literatura in viri / Readings:

- I. S. Sandler, Chemical, Biochemical, and Engineering Thermodynamics, Wiley, 4th Edition, 2006, 945 strani (45 %).

Dopolnilna literatura.

- B. E. Poling, J. M. Prausnitz, J. P. O'Connel, The Properties of Gases and Liquids, McGraw Hill, 5th Edition, 2001.
- H. D. Baehr, Thermodynamik, Springer Verlag, 11. Auflage, 2002, 644 strani.

Cilji in kompetence:	**Objectives and Competences:**

Predmet predstavlja osnovna znanja, ki so potrebna slušateljem kemijskega inženirstva, saj le z razumevanjem principov kemijsko inženirske termodinamike, poznavanjem ustreznih metod in orodij lahko pristopijo k načrtovanju naprav, procesov in produktov. Na realnih problemih bodo študentje pridobili sposobnost analize problema in sinteze znanj v povezavi s fluidno mehaniko, separacijskimi procesi, načrtovanjem reaktorjev, kot tudi biokemijskim inženirstvom.	Course provides understanding of fundamental principles of chemical engineering thermodynamics necessary for all chemical engineers since only understanding of suitable methods and tools enables design of equipment, processes and products. On the basis of actual problems, students will acquire the abilities to analyze problems and relate their knowledge with fluid dynamics, separation processes, reactor design as well as biochemical engineering.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
Znanje in razumevanje Študent po osvojitvi pojmov, teorij in modelov pridobi razumevanje termodinamskega snovnega obnašanja, sposobnost matematične formulacije, ter ob reševanju konkretnih primerov realnih snovnih sistemov pridobi osnovno razumevanje procesno relevantnih povezav v kemijskem inženirstvu.	Knowledge and Comprehension Students acquire basics, theory and models necessary to understand thermodynamic behaviour, capability of mathematical formulation and by solving specific real cases acquire understanding of relevant relations within chemical engineering.
Uporaba Pridobljena znanja bodo študentom omogočila samostojen pristop k reševanju kemijsko inženirskih problemov kot načrtovanje procesa, optmizacija procesa, ocena možnih vplivov kemikalij na okolje ob raznih dogodkih v kemijski industriji, analizo biokemijskih procesov, načrtovanju produktov, identificiranju kemikalije ali mešanice, ki nudi lastnosti, potrebne za določeno aplikacijo in pd.	Application Acquired knowledge enables students an advanced approach for solving chemical engineering problems such as process design, process optimisation, influence of chemicals on environment, analysis of biochemical processes, product design, identification of compounds and their mixtures needed for particular applications, etc.
Refleksija Študent je sposoben razumevanja osnovnih principov kemijskega inženirstva, sposoben je analizirati in kritično ovrednotiti posamezne izbrane termodinamske modele pri reševanju aktualnih inženirskih problemov ter uporabiti pridobljeno znanje na vseh področjih kemijskega inženirstva.	Analysis Student is capable to understand basic principles of chemical engineering, to analyse and critically evaluate different thermodynamic models for their application of engineering challenges as in all areas of chemical engineering.
Prenosljive spretnosti Sposobnost uporabe literature, zbiranja in interpretacije podatkov, sposobnost identifikacije, analize in reševanja inženirskih problemov. Kritična presoja rezultatov ter sposobnost predstavitve postopka reševanja problema v pisni in ustni obliki.	Skill-transference Ability Ability to use literature and proper data interpretation, identification, analysis and solving of engineering problems. Critical evaluation of results and presentation of the problem in written and oral form.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Predavanja, seminarji oz. projektna naloga.	Lectures, seminars or project work.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni in ustni izpit.	**80%**	Written and oral exam
Seminarska naloga.	**20%**	Seminar (project work).

Reference nosilca / Lecturer's references:

Zacharis, Constantinos K., Kalaitzantonakis, Eftichios A., Podgornik, Aleš, Theodoridis, Georgios A. Sequential injection affinity chromatography utilizing an albumin immobilized monolithic column to study drug-protein interactions. *J. chromatogr., A*, 2007, issue 1, vol. 1144, str. 126-134. [COBISS.SI-ID 3420024]

Lendero Krajnc, Nika, Smrekar, Franc, Štrancar, Aleš, Podgornik, Aleš. Adsorption behavior of large plasmids on the anion-exchange methacrylate monolithic columns. *J. chromatogr., A*, 2011, vol. 1218, iss. 17, str. 2413-2424, doi: 10.1016/j.chroma.2010.12.058.

Bednar, Ingeborg, Tscheließnig, Rupert, Berger, Eva, Podgornik, Aleš, Jungbauer, Alois. Surface energies of hydrophobic interaction chromatography media by inverse liquid chromatography. *J. chromatogr., A*, 2012, vol. 1220, str. 115-121, doi: 10.1016/j.chroma.2011.11.001.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	KEMIJSKO INŽENIRSTVO I
Course Title:	CHEMICAL ENGINEERING I

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
UŠP Kemijsko inženirstvo, 1. stopnja	**/**	**1.**	**2.**
USP Chemical Egineering, 1st Cycle	**/**	**1st**	**2nd**

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: IN111

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

Nosilec predmeta / Lecturer: prof. dr. Matjaž Krajnc / Dr. Matjaž Krajnc, Full Professor

Jeziki / Languages:

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

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):
Uvod: Pomen kemijskega inženirstva v svetu tehnike, znanosti in gospodarstva. Domena in smeri razvoja kemijskega inženirstva. Področja aktivnosti kemijskega inženirja. Osnovna matematična orodja: procesne spremenljivke, predstavitev in analiza eksperimentalnih podatkov, metoda najmanjših kvadratov. Računski primeri. Koncept kvantitativnega reševanja kemijsko-inženirskih problemov: definicija sistema, nastavitev problema, matematični zapis, reševanje, verifikacija. Računski primeri. Splošne masne bilance stacionarnih in nestacionarnih sistemov. Računski primeri z	Introduction (significance of chemical engineering in the world of technology, science and economy, development trends in chemical engineering, chemical engineer's line of activity). Process variables, presentation and analysis of experimental data, the least square method, calculus examples. The concept of quantitative solving of chemical-engineering problems (definition of the system, determination of the problem, mathematical formulation, solving and verification, calculus examples). General material balances of steady and unsteady state systems (calculus examples with consideration of the phase equilibrium, chemical reaction and mass transport). The

upoštevanjem faznega ravnotežja, kemijske reakcije in prenosa snovi. Proces in procesna shema. Osnovne procesne spremenljivke. Osnovne faze kemijskega procesa: priprava, kemijska pretvorba, izolacija in čiščenje produkta. Šaržni, kontinuirni in polšaržni procesi, povratni tok (recikel). Primeri sinteze posameznih postopkov v proces. Računski primeri.	process and the processing scheme (the basic processing variables, the basic phases of chemical process: preparation, chemical conversion, isolation and purification of product, batch, continuous and semi batch processes, recurring or recycle flow). Examples of synthesis of individual procedures into the process (calculus examples).

Temeljna literatura in viri / Readings:

- R.M.Felder and R.W.Rousseau: Elementary Principles of Chemical Processes. John Wiley & Sons, 2005, 675 str. (30%)

Cilji in kompetence:	**Objectives and Competences:**
Cilji predmeta: študent osvoji osnovna kemijsko inženirska znanja potrebna pri nadaljevanju študija in pozneje pri opravljanju poklica, zmožnost za osnovno analizo, sintezo in kvantitativno vrednotenje enostavnih kemijsko tehnoloških procesov. Predmetno specifične kompetence: - razume značilnosti kemijsko inženirske stroke - zna identificarti problem, ga rešiti in predstaviti v kvantitativni obliki - pri praktičnih reševanju primerov zna uporabiti snovne in energijske bilance, matematična orodja in osnovne kemijske in fizilkalne zakone- - zna analizirati proces in procesno shemo - razvija interes za obravnavanje inženirskih problemov.	Understanding of characteristics in the chemical engineering field. Ability to identify the problem, solve it and to interpret it in quantitative form. The knowledge of using material and energy balances, mathematical tools and basic chemical and physics laws to solve practical problems. Ability to analyze processes and the processing schemes. To develop an interest in engineering problem proceedings.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
Znanje in razumevanje Študent bo po osvojitvi pojmov, zakonitosti, teorij in pojavov, ki jih podaja ta predmet, sposoben razumeti specifičnosti kemijsko inženirske stroke ter pomena matematike, fizike, kemije, računalništva in osnovnih principov kemijskega inženirstva v kemijski procesni tehniki.	Knowledge and Comprehension Understanding of basic principles of chemical engineering knowledge required in further courses and later, during employment. Ability for basic analysis, synthesis and quality evaluation of plain chemical technology processes.

Uporaba Pridobljena znanja o kemijsko inženirskih zakonitostih in principih je sposoben uporabiti pri reševanju posameznih praktičnih računskih primerov in problemov v kemijski procesni tehniki in v nadaljnjem študiju na dodiplomski zahtevnostni stopnji.	Application Student is able to apply the knowledge of chemical engineering principles in solving specific practical calculation cases in chemical process technology problems. The acquired knowledge is necessary for further study.
Refleksija Študent bo razumel osnovne principe kemijskega inženirstva in razvil veščine za analizo in kritično ovrednotenje tehnološke sheme procesa oziroma posamezne naprave.	Analysis Student understands basic principles of chemical engineering and develops skills for analysis and critical evaluation of technological scheme or specific equipment.
Prenosljive spretnosti Razvita sposobnost identifikacije in reševanja problemov, kritičnega razmišljanja in logičnega sklepanja. Sposobnost uporabe literature, zbiranja in interpretacije podatkov in njihove kritične evalvacije ter sposobnost predstavitve rezultatov reševanja problema oziroma poročanja v pisni in ustni obliki.	Skill-transference Ability Ability of identifying and solving problems, critical thinking and deduction; Ability of gathering, selecting and interpreting data and their critical evaluation; Ability of comprehensive results presentation.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Predavanja in seminarji.	Lectures and seminars.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni izpit.	**80 %**	Written exam.
Seminarska naloga in predstavitev.	**20 %**	Project work; written report and oral presentation.

Reference nosilca / Lecturer's references:

- ŠINKOVEC, Ervin, POHAR, Andrej, KRAJNC, Matjaž. Phase transfer catalyzed esterification : modeling and experimental studies in a microreactor under parallel flow conditions. *Microfluidics and nanofluidics*, ISSN 1613-4982, 2013, vol. 14, no. 3/4, str. 489-498. [COBISS.SI-ID 36262917]
- LIKOZAR, Blaž, KRAJNC, Matjaž. Cross-linking of polymers : kinetics and transport phenomena. *Industrial & engineering chemistry research*, ISSN 0888-5885. [Print ed.], 2011, vol. 50, no. 3, str. 1558-1570. [COBISS.SI-ID 35022341]
- LIKOZAR, Blaž, KRAJNC, Matjaž. Simulation of chemical kinetics of elastomer crosslinking by organic peroxides. *Polymer engineering and science*, ISSN 0032-3888, 2009, vol. 49, no. 1, str. 60-72. [COBISS.SI-ID 30003205]

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	KEMIJSKO INŽENIRSTVO II
Course Title:	CHEMICAL ENGINEERING II

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
UŠP Kemijsko inženirstvo, 1. stopnja	**/**	**2.**	**4.**
USP Chemical Egineering, 1st Cycle	**/**	**2nd**	**4th**

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: IN119

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

Nosilec predmeta / Lecturer: prof. dr. Matjaž Krajnc / Dr. Matjaž Krajnc, Full Professor

Jeziki / Languages:

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

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):
Temeljna vsebinska področja predmeta so: - energijske bilance: reakcijski in separacijski procesi; entalpijske spremembe; - numerično reševanje navadnih diferencialnih enačb: analitična metoda, Eulerjeva metoda, Rungejeva trapezna metoda, Runge-Kutta-klasična metoda četrtega reda, sistem navadnih diferencialnih enačb; - numerično reševanje parcialnih diferencialnih enačb: eksplicitna in implicitna metoda končnih razlik, analitična in numerična rešitev Laplaceove enačbe; - zapis in reševanje ohranitvenih enačb; - povečevalni kriteriji; - uporaba računalniških orodij (npr.: *Mathematica, Comsol, Matlab*).	Energy balances: reaction and separation processes, enthalpy changes. Numerical solutions of ordinary differential equations: analytical method, Euler method, trapezoid method, common 4th order Runge-Kutta method, system of ordinary differential equations. Numerical solutions of partial differential equations: explicit and implicit finite difference methods, analytical and numerical solution of Laplace equation; writing down and solving conservation equations; Scale-up criteria; Software use (*Mathematica, Comsol, Matlab*,...).

Temeljna literatura in viri / Readings:

- I. Plazl in M. Lakner, Uvod v modeliranje procesov, Založba FKKT, Univerza v Ljubljani, Ljubljana, 2004, 230 str., (90 %).
- R. M. Felder in R. W. Rousseau, Elementary principles of chemical processes, 3. Izdaja, John Wiley and Sons, Inc., New York, 2000, 675 str., (30 %).

Dopolnilna literatura:

- C. F. Gerald in P. O. Wheatley, Applied numerical analysis, 7. izdaja, Addison Wesley, New York, 2003, 624 str.

Cilji in kompetence:	**Objectives and Competences:**
Cilj predmeta je, da študentje osvojijo osnovna načela zapisa energijskih bilanc in matematična orodja za reševanje ohranitvenih enačb. Študentje pri predmetu pridobijo naslednje specifične kompetence: - poznavanje splošnih načel zakona o ohranitvi energije; - poznavanje konstitutivnih zvez in obratovalnih pogojev; - sposobnost zapisa ohranitvenih enačb z upoštevanjem robnih pogojev; - poznavanje osnovnih matematičnih orodij za reševanje navadnih in parcialnih diferencialnih enačb.	Acquisition of knowledge on general concepts of energy conservation. Acquisition of knowledge on constitutional equations and operational conditions; writing down conservation equations by taking into account of boundary conditions. Using basic mathematical tools for solving ordinary and partial differential equations.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
Znanje in razumevanje Študentje pridobijo temeljna znanja o matematičnem zapisu ohranitvenih enačb z vključitvijo konstitutivnih zvez in upoštevanjem procesnih pogojev. Pridobljena znanja numeričnih metod jim omogočajo kvantitativno obravnavo in analizo preprostejših kemijskih procesov.	Knowledge and Comprehension Understanding the basic principles of energy and mass balance equations. Capability of implementing conservation balance equations by the use of mathematical tools.
Uporaba Pridobljena znanja je sposoben uporabiti pri samostojnem razvojnem in raziskovalnem delu na področjih analize, načrtovanja in optimizacije procesov.	Application Student is able to apply the knowledge at independent research and development work in the field of process analysis, design and optimization.

Refleksija Študent je sposoben samostojno sklepati, definirati problem, postavljati zaključke in probleme reševati.	Analysis Development of abilities of autonomous deducting, problem defining, problem solving, and coming to conclusions.
Prenosljive spretnosti Zna identificirati in reševati probleme, sposoben je zbiranja in interpretacije podatkov, kritične analize in sinteze pridobljenih znanj.	Skill-transference Ability Ability to identify and solve problems, to collect and interpret data, to analyse results critically and to synthesize knowledge.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
- predavanja, - seminarji	Lectures and seminars.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni izpit.		Written exam.

Reference nosilca / Lecturer's references:

- ŠINKOVEC, Ervin, POHAR, Andrej, KRAJNC, Matjaž. Phase transfer catalyzed esterification : modeling and experimental studies in a microreactor under parallel flow conditions. *Microfluidics and nanofluidics*, ISSN 1613-4982, 2013, vol. 14, no. 3/4, str. 489-498. [COBISS.SI-ID 36262917]
- LIKOZAR, Blaž, KRAJNC, Matjaž. Cross-linking of polymers : kinetics and transport phenomena. *Industrial & engineering chemistry research*, ISSN 0888-5885. [Print ed.], 2011, vol. 50, no. 3, str. 1558-1570. [COBISS.SI-ID 35022341]
- LIKOZAR, Blaž, KRAJNC, Matjaž. Simulation of chemical kinetics of elastomer crosslinking by organic peroxides. *Polymer engineering and science*, ISSN 0032-3888, 2009, vol. 49, no. 1, str. 60-72. [COBISS.SI-ID 30003205]

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	KEMIJSKO PRODUKTNO INŽENIRSTVO
Course Title:	CHEMICAL PRODUCT ENGINEERING

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
UŠP Kemijsko inženirstvo, 1. stopnja	**/**	**3.**	**5.**
USP Chemical Egineering, 1st Cycle	**/**	**3rd**	**5th**

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: IN133

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

Nosilec predmeta / Lecturer: prof. dr. Urška Šebenik / Dr. Urška Šebenik, Full Professor

Jeziki / Languages: **Predavanja / Lectures:** **slovenski / Slovenian**; **Vaje / Tutorial:** **/**

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):
- Definicija načrtovanja kemijskih produktov; - Piramida kemijskega produkta: materiali in sestava, uporaba, proces izdelave, struktura in lastnosti produkta; - Osnovni koraki pri načrtovanju produktov in procesov, ki vključujejo definicijo problema in potencialne tehnične rešitve ob upoštevanju ekonomskih, varstvenih in okoljskih dejavnikov; - Opredelitev in interpretacija potreb uporabnika kemijskega produkta; - Pretvorba potreb v specifikacije produkta; - Razvoj idej za zadovoljitev potreb uporabnika (načini iskanja in tvorjenja idej, izvori za	- Definition of chemical product design; - The chemical product pyramid: materials and composition, use, process, structure and performance of a chemical product; - Basic steps in product and process design with problem definition and possible technical solutions; - Definition and interpretation of market needs; - Converting needs to specifications; - Generation, collection and development of ideas for products that will satisfy marked needs; - Idea selection: verification of ideas' feasibility on the basis of thermodynamic laws and

potencialne ideje, določitev pomembnih dejavnikov za oblikovanje idej); - Izbor idej: ocena izvedljivosti idej na osnovi termodinamskih zakonitosti in kriterijev, ki jih opredeljujejo transportni pojavi in kemijska kinetika ob upoštevanju okoljskih, ekonomskih in proizvodnih tveganj; - Razvoj procesa za izdelavo produkta, ki vključuje zbiranje in selekcijo podatkov, končno specifikacijo produkta, določitev procesnih naprav in procesno shemo; - Načrtovanje kemijskega produkta na osnovi kemijske strukture; - Načrtovanje formuliranega produkta na osnovi mikrostrukture; - Preliminarna sinteza procesa na osnovi fizikalnih in kemijskih parametrov, kemijskih reakcij, transporta snovi in reciklov, separacijskih procesov, faznih sprememb - združevanje posameznih operacij v osnovne procesne sheme; - Primeri načrtovanja kemijskih produktov.	criteria, which are defined by transport phenomena and chemical kinetics and by taking into account economic, safety and environmental issues; - Development of a process for a product production based on data acquisition and selection, product specification, process equipment selection and process scheme; - Product design based on its chemical structure; - Formulated product design based on its microstructure; - Preliminary synthesis of the process on the basis of chemical and physical parameters, chemical reactions, mass transport, recycles, separation processes, phase changes - integration of operational units into a process scheme; - Case studies of chemical product design.

Temeljna literatura in viri / Readings:

- E. L. Cussler in G. D. Moggridge, Chemical Product Design, Cambridge University Press, Cambridge, 2001, 230 str., (80 %).
- J. A. Wesselingh, S. Kiil, M. E. Vigild, Design and Development of Biological, Chemical, Food and Pharmaceutical Products, John Wiley and Sons Ltd, Chichester, 2007, 293 str., (40 %).

Dopolnilna literatura:

- L. T. Biegler, I. E. Grossmann, A. W. Westerberg, Isues and Trends in the Teaching of Process and Product Design, AIChE Journal, 2010, 56(5), 1120-1125.
- W. D. Seider, J. D. Seider, D. R. Lewin, Product and Proces Design Principles, 2nd Ed., John Wiley & Sons, New York, 2004, 800 str..
- U. Bröckel, W. Meier in G. Wagner, Product Desgn and Engineering, Volume 1: Basics and Technologies, Wiley-VCH Verlag GmbH and Co. KgaA, Weinheim, 2007, 308 str..
- U. Bröckel, W. Meier in G. Wagner, Product Desgn and Engineering, Volume 2: Rawmaterials, Additives and Applications, Wiley-VCH Verlag GmbH and Co. KgaA, Weinheim, 2007, 394 str..

Cilji in kompetence:	**Objectives and Competences:**
Cilj predmeta je, da študentje osvojijo metodološki pristop k razvoju novih produktov, ki vključuje analizo potreb. Študent osvoji različne stopnje razvoja kemijskih produktov in splošni pristop k definiranju potencialnih tehničnih rešitev ob upoštevanju	Acquisition of methodological approaches for developing new products, including a market needs analysis; Understanding different stages of development of new products; Understanding general approaches for defining possible technical solutions by taking into

ekonomskih, varstvenih in okoljskih dejavnikov. Študentje pri predmetu pridobijo naslednje specifične kompetence: - poznavanje načinov opredelitve in interpretacije potreb trga; - sposobnost uporabe kemijsko inženirskih znanj za izbiro idej in določevanje potencialnih rešitev; - sposobnost analize in interpretacije relevantnih podatkov; - razumevanje povezave kemijsko inženirskih znanj in ekonomskih dejavnikov za načrtovanje okolju sprejemljivih procesov; - razvijanje sposobnosti tehniškega mišljenja v okviru okoljskih dejavnikov; - poznavanje izbora relevantnih kemijskih in fizikalnih lastnosti, potrebnih za načrtovanje produkta; - sposobnost izbora posameznih operacij; - sposobnost sinteze naprav v integralno procesno shemo; - razumevanje načinov optimizacije predlaganih procesnih shem.	account economical, safety and environmental issues. Ability to define and interpret market needs; Ability to use chemical engineering knowledge to create ideas and define potential solutions; Ability to analyze and interpret relevant data; Understanding the relationships between economic and ecological issues; Development of technical thinking within the sphere of environmental factors; Ability to choose appropriate key chemical and physical properties needed for product design; Ability to select required operations; Ability to integrate operational units (apparatus) into a process scheme; Understanding the process scheme optimization approach.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
Znanje in razumevanje Študent zna identificirati ključne dejavnike pri razvoju kemijskih produktov. Razume zvezo med osnovnimi kemijsko inženirskimi znanji in specifičnimi lastnostmi kemijskega produkta. Pozna osnovno metodologijo razvoja produkta in procesa za zadovoljitev potreb trga. Zna upoštevati ekonomske in okoljske dejavnike pri načrtovanju procesa za kemijski produkt.	Knowledge and Comprehension Ability to identify key factors in chemical product development; Understanding the relationship between basic chemical engineering knowledge and specific chemical product properties; Knowledge of the basic methodology for product and process development; Ability of identifying and taking into account economical, safety and environmental issues.
Uporaba Študent je pridobljena znanja sposoben uporabiti pri razvojnem in raziskovalnem delu na področjih razvoja in optimizacije produktov.	Application Acquired knowledge is necessary for work, research and development in the field of product development and optimization.
Refleksija Študent je sposoben sintetizirati pridobljena kemijsko inženirska znanja in jih uporabiti pri reševanju kompleksnih specifičnih problemov.	Analysis Student is able to synthesize chemical engineering knowledge to solve specific complex problems; Student is able of

Pridobljeno znanje mu omogoča aktivno komuniciranje in sodelovanje na interdisciplinarnih področjih.	communication and cooperation in interdisciplinary fields of work.
Prenosljive spretnosti Razvita sposobnost kritičnega razmišljanja in logičnega sklepanja. Sposobnost zbiranja in interpretacije podatkov ter sposobnost predstavitve rezultatov razvojnega in raziskovalnega dela.	Skill-transference Ability Ability of critical thinking and deduction; Ability of gathering, selecting and interpreting data. Ability of comprehensive results presentation.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Predavanja, seminarji – projektno delo v manjših skupinah	Lectures and seminars (project work in small groups).

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Seminarska naloga – izvedba, pisno poročilo in predstavitev Pisni in ustni izpit		Project work - attendance, written report and presentation Written and oral exam

Reference nosilca / Lecturer's references:

- ALIČ, Branko, **ŠEBENIK, Urška**, KRAJNC, Matjaž. Microencapsulation of butyl stearate with melamine-formaldehyde resin : effect of decreasing the pH value on the composition and thermal stability of microcapsules. *Express polymer letters*, ISSN 1788-618X, 2012, vol. 6, no. 10, str. 826-836. [COBISS.SI-ID 36126469].
- **ŠEBENIK, Urška**, KRAJNC, Matjaž. Properties of acrylic-polyurethane hybrid emulsions synthesized by the semibatch emulsion copolymerization of acrylates using different polyurethane particles. *Journal of polymer science. Part A, Polymer chemistry*, ISSN 0887-624X, 2005, vol. 43, no. 18, str. 4050-4069. [COBISS.SI-ID 26883589]
- **ŠEBENIK, Urška**, KARGER-KOCSIS, József, KRAJNC, Matjaž, THOMANN, Ralf. Dynamic mechanical properties and structure of in situ cured polyurethane/hydrogenated nitrile rubber compounds: effect of carbon black type. *Journal of applied polymer science*, ISSN 0021-8995, 2012, vol. 125, no. S1, str. E41-E48. [COBISS.SI-ID 35685381]

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	KEMIJSKO REAKCIJSKO INŽENIRSTVO
Course Title:	CHEMICAL REACTION ENGINEERING

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
UŠP Kemijsko inženirstvo, 1. stopnja	**/**	**3.**	**5.**
USP Chemical Egineering, 1st Cycle	**/**	**3rd**	**5th**

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: IN131

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Work	Druge oblike študija	Samost. delo Individual Work	ECTS
60	**15**	**/**	**/**	**/**	**75**	**5**

Nosilec predmeta / Lecturer: prof. dr. Aleksander Pavko / dr. Aleksander Pavko, Full Professional

Jeziki / Languages:

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

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:

Kemijska reakcija in stehiometrija. Kinetični in termodinamski podatki. **Teoretična napoved hitrosti reakcije.** Teorija trkov in teorija prehodnega stanja. Kinetične enačbe enostavnih in sestavljenih homogenih reakcij. **Kemijski reaktor.** Osnove dimenzioniranja. Snovna in toplotna bilanca. Oblika toka v reaktorju. Idealni in realni reaktorji. **Reaktorji za enostavne homogene reakcije.** Izotermni in neizotermni pogoji. Šaržni reaktor. Mešalni reaktor. Cevni reaktor. Mešalni reaktorji v vrsti. Cevni reaktor z obtokom. Adiabatni mešalni reaktor in stabilno obratovanje. **Reaktorji za vzporedne in**

Content (Syllabus outline):

Chemical reaction and stiochiometry. Kinetic and thermodynamic data. **Theoretical predictions of the rate of reaction.** Theory of transition state. Kinetic equations of simple and complex homogenous reactions. **Chemical reactor.** Fundamentals of dimensioning. Mass and heat balance. Form of flow in a reactor. Ideal and real reactors. **Reactors for simple homogenous reactions.** Isotermal and non-isothermal conditions. Batch reactor. Stirred tank reactor. Tubukar reactor. Mixed flow reactors in series. Tubular recycle reactor. Adiabatic stirred tank reactor and stable operation. **Reactors for simultaneous and multistep homogenous reactions**. Homogenous

zaporedne homogene reakcije. Homogene katalitske reakcije. Selektivnost. **Porazdelitev zadrževalnih časov (RTD) fluida v reaktorju.** Mikro in makro fluid. Vzbujevalno-odzivna tehnika. Pulzna in stopničasta motnja. Neposredna uporaba RTD krivulj. Disperzno-čepasti model. Model mešalnih reaktorjev v vrsti. Dvo in več-parametrski modeli.	catalytic reactions. Selectivity. **Residence time distribution (RTD) of fluid in a reactor**. Micro and macro fluid. Stimulus-response technique. Pulse and step stimulus. Direct application of RTD curves. Dispersion model. Tank in series mode. Two and multi-parameter models.

Temeljna literatura in viri / Readings:

- O. Levenspiel, *Chemical Reaction Engineering*, 3. izdaja, Wiley, 1999, 668 strani (70%).
- G. W. Roberts, *Chemical Reactions and Chemical Reactors*, 1. izdaja, Wiley, 2008, 452 strani (70 %).

Cilji in kompetence:	**Objectives and Competences:**
Predmet študentu razvija sposobnost analize in sinteze kompleksnih procesov s snovno pretvorbo (reakcijo), saj opovezuje kemijsko kinetiko in kemijsko termodinamiko na eni strani, z inženirsko termodinamiko in transportnimi pojavi na drugi. Tako ponuja znanja, ki so potrebna za obravnavanje in načrtovanje procesov s kemijsko reakcijo oziroma naprav (reaktorjev), ko te potekajo v eni sami (homogeni) fazi. Specifične kompetence predmeta so: - poznavanje, razumevanje in uporaba zakonov o ohranitvi mase, energije in gibalne količine, ko se kemijske pretvorbe odvijajo v homogeni fazi, - poznavanje, razumevanje in uporaba matematičnih zapisov hitrosti kemijskih pretvorb (kinetičnih enačb) v homogenih sistemih, poznavanje in razumevanje razlogov za odmik od idealnega toka v reaktorjih in reševanje takih problemov.	This course develops student ability for analysis and synthesis of complex processes with chemical transformation (reaction) since it links chemical kinetics and thermodynamics together with engineering thermodynamics and transport phenomena. It offers knowledge necessary to treat and design single phase chemical reaction processes and equipment. Specific competences are: - Knowing, understanding and using the laws of mass, energy and momentum conservation, when chemical reaction takes place in a homogenous phase, - Knowing, understanding and using mathematical expressions for chemical reactions (kinetic equations) in homogenous systems, - Knowing and understanding reasons for deviations from an ideal flow in reactors and solving such problems.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
<u>Znanje in razumevanje</u> Študent spozna osnovne zakonitosti v zapisovanju hitrosti kemijskih in fizikalnih sprememb na infinitizemalni ravni reaktorja, ki po integraciji po prostoru reaktorja daje zvezo	<u>Knowledge and Comprehension</u> Student learns basic principles of writing down kinetic equations for a infnitesimal reactor volume, which after integration in a space gives a relation between operation conditions and reactor yield on a macro scale.

med obratovalnimi pogoji in reaktorjevim dobitkom na makro skali.	
Uporaba Ta znanja mu omogočajo analizo obratovanja obstoječih in načrtovanje novih reaktorjev za vodenje reakcij v enostavnih homogenih sistemih.	Application Knowledge enables performance analysis of existing reactors as well as design of reactors in simple homogenous systems.
Refleksija Študent je sposoben uporabiti znanja iz matematike, fizike, kemije, transportnih pojavov in pridobiti poglobljeno sliko o dogajanju v reaktorju na mikro nivoju. Pri zahtevnem načrtovanju kemijskih reaktorjev in drugih procesnih naprav, mu ta sposobnost omogoča tudi komuniciranje/sodelovanje z drugimi inženirji.	Analysis Student is able to use mathematical, physical, chemical and transport phenomena knowledge to obtain the profound picture of the processes in a reactor on a micro level.
Prenosljive spretnosti Študent je usposobljen za eksperimentalno delo z enostavnimi reakcijskimi sistemi, pa tudi za delo pri prenašanju eksperimentalnih rezultatov in literaturnih podatkov v industrijsko prakso. Sposoben je analizirati obstoječe naprave, določiti optimalne pogoje obratovanja in načrtovati nove reaktorje za homogene reakcijske sisteme.	Skill-transference Ability Student is capable to perform experimental work in simple reaction systems as well as transfer of experiemental and literature data to industrial practice. He can analyze the performance of existing equipment, estimate optimal operating conditions and design new reactors for homogenous systems.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Predavanja in seminarji. V sklopu Kemijskega inženirskega praktikuma v 6. semestru študent opravi tudi eksperimente na treh osnovnih tipih reaktorjev in tako utrdi pridobljeno znanje.	Lectures and seminars.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Ustni in pisni izpit.		Written and oral exam.

Reference nosilca / Lecturer's references:

- BOLČIČ TAVČAR, Mateja, SVOBODOVÁ, Kateřina, BABIČ, Janja, NOVOTNÝ, Čeněk, PAVKO, Aleksander. Biodegradation of azo dye RO16 in different reactors by immobilized Irpex lacteus. *Acta chimica slovenica*, 2006, letn. 53, št. 3, str. 338-343.
- PAVKO, Aleksander, LEVEC, Janez. Kinetics in three-phase reactors. *Chemical engineering journal*, 1981, vol. 21, str. 149-154**.**
- LEVEC, Janez, PAVKO, Aleksander, DOBOVIŠEK, Mirko. Effectiveness factor for partially wetted catalyst particles. *Chemical Engineering Science*, 1980, vol. 35, str. 1815-1816.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	KVANTNA MEHANIKA
Course Title:	QUANTUM MECHANICS

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
UŠP Kemijsko inženirstvo, 1. stopnja	**/**	**2.**	**4.**
USP Chemical Egineering, 1st Cycle	**/**	**2nd**	**4th**

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: IN117

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

Nosilec predmeta / Lecturer: prof. dr. Barbara Hribar Lee/ dr. Barbara Hribar Lee, Full Professor

Jeziki / Languages:

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

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):
Osnove kvantne mehanike: fotoni, valovanje, delci. Principi: operatorji, lastne funkcije in lastne vrednosti, pričakovane vrednosti, Heisenbergov in Paulijev princip. Prehodi med kvantnimi stanji. Opis in reševanje enostavnejših sistemov: delci ob pregradah in v potencialnih jamah, togi rotator, harmonski oscilator, vodikov atom (atomske orbitale). Metode za približno računanje: variacijska metoda in metoda motenj. Modeli za obravnavanje molekulskih sistemov: teorija valenčnih vezi in teorija molekulskih orbital. Kemijska vez. Dvoatomne molekule, večatomne molekule in trdnine z molekularno orbitalno teorijo, gostotni funkcionali.	Introduction to quantum mechanics (quantum phenomena, photons, particles, waves); Principles (quantum operators, commutation, expectation values, Schrödinger equation); Heisenberg principle, wave – particle duality, Pauli principle. Transitions between quantum states, transition moments; Model systems (free particle, particle in a box, tunnelling effect, rotators, oscillators, hydrogen atom); Approximate calculations (variation methods, perturbation theory); Models for calculating molecular properties (molecular orbital method, valence bond theory); Chemical bond; Diatomic, polyatomic molecules and solid state systems with molecular orbital method, density

Računalniška kvantna kemija, glavne metode in računski modeli, pregled pomembnih računalniških sistemov na tem področju (Gaussian, Spartan, HyperChem ...), prikaz praktičnega dela z računalnikom na konkretnem problemu, individualno obravnavanje enostavnejših primerov s pomočjo metod računalniške kvantne kemije. Računalniška grafika.	functionals; Computational chemistry, important methods and computational models, overview of some computer programs (Gaussian, Spartan, HyperChem); presentation of practical work on a concrete problem using computer; Computer graphics.

Temeljna literatura in viri / Readings:

- S.M. Blinder, Introduction to Quantum Mechanics in Chemistry, Materials Science, and Biology, Elsevier Academic Press, Burlington 2004, 307 str., (65 %)
- J. Koller, Struktura atomov in molekul (bolonjski program), FKKT, Ljubljana 2010, 209 str.

Dopolnilna literatur/Additional Literaure:

- A.R. Leach, Molecular Modelling, Principles and Applications, Addison Wesley Longman, London 1998, 585 str.
- J. Koller, Struktura atomov in molekul – zbirka nalog z rešitvami, FKKT, Ljubljana 2002, 121 str.

Cilji in kompetence:	**Objectives and Competences:**
Cilji: poznavanje elektronske strukture in geometrije molekul (iz osnovnih podatkov), napoved lastnosti molekul in njihova povezava s strukturo, možnost načrtovanja molekul z vnaprej določenimi želenimi lastnostmi. Predmetno specifične kompetence. Študent se nauči uporabljati računalniško grafiko. Spozna pomembne računalniške programe, ki se uporabljajo pri molekulskem modeliranju, sposoben je praktičnega dela na osebnem računalniku, delovni postaji in velikem računalniku (preko računalniške mreže).	***Learning outcomes:*** Understanding the basic principles of quantum mechanics and applying these principles in learning new perspectives of looking at the micro cosmos; Deriving the electronic structure and molecular geometry from the basic data. Designing new materials with required properties. ***Competences:*** Ability to use computer graphics and relevant computer programs for molecular modelling. Independent practical work on a PC or workstation; Interpreting the atomic structure and the structure of simple molecules; abilities for independent theoretical research.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
<u>Znanje in razumevanje</u> Študent se seznani z osnovami kvantne kemije in njeni praktični uporabi, na primer pri molekulskem modeliranju, ki omogoča vpogled na nekatera eksperimentom nedostopna področja kemijske kot tudi znanosti s področja materialov. Ob koncu so sposobni formulirati problem, izbrati primerno teoretično metodo in kritično ovrednotiti dobljene rezultate. Zna tudi poiskati povezavo	<u>Knowledge and Comprehension</u> Students obtain the basic knowledge of quantum chemistry and its practical application, like molecular modelling, which enables them to have an insight of the properties of the matter that cannot be directly measured. At the end of the course they are able to formulate the problem, pick an appropriate theoretical method, and critically assess the results. They

med dobljenimi teoretičnimi in v literaturi najdenimi podatki.	can correlate the obtained theoretical results with the literature data.
Uporaba Slušatelj je sposoben uporabiti znanje kvantne kemije za modeliranje danega znanstvenega problema, komercialne računalniške programske sisteme s tega področja mu ni več potrebno uporabljati kot "black box", zaradi česar lahko tudi mnogo bolj kompetentno razlaga dobljene rezultate.	Application The students are able to apply the knowledge of quantum chemistry to model a given scientific problem. The commercially available software for this kind of problems does not need to be considered as a black box, and as such a more competent interpretation of the results is possible.
Refleksija Študent si pridobi občutek, da se lahko v primeru nepremostljivih eksperimentalnih težav še vedno zateče k računu, kjer so problemi drugačni in navadno drugje, kar pogosto privede do zadovoljive razjasnitve problema.	Analysis The students gain the knowledge that the experimental data can be interpreted through the theoretical methods, where different kinds of difficulties need to be overcome to obtain the meaningful results.
Prenosljive spretnosti Pri predmetu se študenti naučijo prepoznavati problem, ga prevesti v matematično obliko, rešiti in na koncu interpretirati rezultate. Poseben poudarek je na kritičnem ovrednotenju dobljenih rezultatov. Naučijo se uporabe domače in tuje literature ter podajanja zaključenega dela v pisni obliki.	Skill-transference Ability The students lear to recognize the problem, to formulate it in the mathematical language, and to interprete the results. Special attention is payed to critical assesment of the obtained results. They learn how to use the literature and to present a written report.