UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	IZBRANA POGLAVJA IZ SEPARACIJSKIH PROCESOV
Course Title:	SELECTED TOPICS IN SEPARATION PROCESSES

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

Vrsta predmeta / Course Type: izbirni/Elective

Univerzitetna koda predmeta / University Course Code: KZ316

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. Aleš Podgornik / Dr. Aleš Podgornik, Full Professor

Jeziki / Languages:

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Vpis na doktorski program. Osnovno znanje masnih bilanc, termodinamike, prenosa snovi in separacijskih operacij.	Enrolment into the post-graduate (PhD) course. Basic knowledge regarding the mass balances, thermodynamics, mass transfer and separation unit operations.

Vsebina:	Content (Syllabus outline):
- Separacijske operacije v kemijskih, farmacevtskih in biotehnoloških procesih; - Masne in toplotne bilance zahtevnejših procesov s poudarkom na metabolizmu; - Termodinamika neidealnih sistemov tekoče-tekoče ter tekoče-trdno; - Vloga laboratorijskih raziskav in načrtovanje pilotskih enot – povečevalni kriteriji; - Poglavja iz izbranih separacijskih procesov farmacevtskih in biotehnoloških učinkovin: · kristalizacija in precipitacija · dvofazna vodna ekstrakcija	- Separation unit operations in chemical, pharmaceutical and biotechnological processes; - Mass and heat balances of metabolic processes; - Thermodynamics of non-ideal liquid-liquid and liquid-solid systems; - The role of research on laboratory and pilot scale unit - scale up criteria; - Selected separation processes of pharmaceutical and biotechnological products: · crystallization and precipitation

· gradientna Kromatografija · preparativna kromatografija · kontinuirni separacijski procesi - simuliran gibljivi sloj (SMB) · Membranski procesi - Optimizacija separacijskih procesov z več koraki;	· ATPS extraction · gradient chromatography · preparative chromatography · continuous separation processes – simulated moving bed (SMB) · membrane processes - Optimization of separation processes involving several steps;

Temeljna literatura in viri / Readings:

- J. D. Seader, E. J. Henley, Separation process principles, 2nd ed., John Wiley & Sons, 2006
- G. Carta, A. Jungbauer, Protein Chromatography: Process Development and Scale-Up, Wiley-VCH Verlag, Weinheim, 2010
- S. Yamamoto, K. Nakanishi, R. Matsuno, Ion-exchange chromatography of proteins, Marcel Dekker, New York, 1988
- Specialni učbeniki za separacijske procese
- Članki vodilnih revij s področja kemijskega in biokemijskega inženirstva

Cilji in kompetence:	**Objectives and Competences:**
Podiplomski študentje bodo nadgradili temeljna inženirska znanja iz prenosa snovi, termodinamike, masno-toplotnih bilanc in separacijskih operacij ter jih povezali v analizo oziroma načrtovanje zahtevnejših separacijskih procesov, ki vključujejo več korakov. Poseben poudarek bo na farmacevtskih in biotehnoloških procesih, zato bodo spoznali specifike teh sistemov ter njihov prenos v laboratorijskega v industrijsko merilo ter iz šaržnega na kontinuirni način.	Post-graduate students will upgrade their fundamental engineering knowledge of mass transfer, thermodynamics, mass-heat balances and separation unit operation, and implement it for analyses and design of complex separation processes involving several steps. Focus will be on pharmaceutical and biotechnological processes by discussing peculiarities of these systems and their transfer from laboratory to industrial scale and from batch to continuous operation mode.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
<u>Znanje in razumevanje</u> Študent je po osvojitvi znanj tega predmeta sposoben razumeti specifike bioloških sistemov in na osnovi tega izbrati ter dimenzionirati posamezne separacijske korake za specifične sisteme.	<u>Knowledge and Comprehension</u> After completition of course student is able to understand specificities of biologic based systems and by implementing this knowledge to select and design appropriate separation steps for specific systems.
<u>Uporaba</u> Znanja pridobljena pri tem predmetu bodo omogočila študentu kompetentno načrtovanje eksperimentov in procesov, dimenzioniranje separacijskih procesov tako na mikro kot tudi na industrijskem nivoju, ugotavljati kdaj je smiselno uporabljati šaržne in kdaj kontinuirne procese kot tudi poglobljeno analizo obstoječih	<u>Application</u> By implementation of knowledge acquired throughout this course student will be able to competently design experiments and processes involving separation operations from micro scale to industrial level, to evaluate when batch or continuous processes should be implemented as well as to provide in-depth analysis of specific

procesov. Pri tem bo sposoben uporabljati sodobne računalniške metode načrtovanja in optimizacije.	existing processes. This will achieve using modern computer based methods of analysis and optimization.
Refleksija Na osnovi primerjav med kemijskimi in biološkimi separacijskimi sistemi bo identificiral podobnosti in s tem razumel bistvene principe s čimer bo sposoben sklepati na izbor ustreznih separacijskih tehnik za poljubne sisteme. Skupaj z ostalimi inženirskimi znanji transportnih pojavov, kemijskega in faznega ravnotežja, toplotnih in masnih bilanc ter reakcijske kinetike bo lahko pridobil celovito razumevanje najkompleksnejših procesov.	Analysis Based on parallels between chemical and biologic separation systems, student realizes similarities among them and by this, underlying physical principles, what will enable selection of appropriate separation operation for any system. By combining and interconnecting chemical engineering knowledge of transport phenomena, chemical and phase equilibrium, mass and heat balances and chemical kinetics student obtain comprehensive understanding of most complex systems.
Prenosljive spretnosti Algoritmičen koncept pristopa načrtovanja separacijskih operacij v kompleksnih kemijskih, farmacevtskih in biotehnoloških procesih bo lahko prenesel tudi na druga področja kot so biologija, medicina, ved o okolju in ved o materialih.	Skill-transference Ability Algorithmic based concept of designing separation steps in complex chemical, pharmaceutical and biotechnological processes will be able to transfer on other areas such as biology, medicine, environmental sciences and material sciences.

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

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Seminar Ustni izpit	80% 20%	Seminar Oral examination

Reference nosilca / Lecturer's references:

PODGORNIK, Aleš, SMREKAR, Vida, KRAJNC, Peter, ŠTRANCAR, Aleš. Estimation of methacrylate monolith binding capacity from pressure drop data. *Journal of chromatography. A*, ISSN 0021-9673, 11. Jan. 2013, vol. 1272, str. 50-55, doi: 10.1016/j.chroma.2012.11.057. [COBISS.SI-ID 16493846]

SMREKAR, Vida, SMREKAR, Franc, ŠTRANCAR, Aleš, PODGORNIK, Aleš. Single step plasmid DNA purification using methacrylate monolith bearing combination of ion-exchange and hydrophobic groups. *Journal of chromatography. A*, ISSN 0021-9673, 2013, vol. 1276, str. 58-64, doi: 10.1016/j.chroma.2012.12.029. [COBISS.SI-ID 4199288]

PODGORNIK, Aleš, YAMAMOTO, Shuichi, PETERKA, Matjaž, LENDERO KRAJNC, Nika. Fast separation of large biomolecules using short monolithic columns. *Journal of chromatography. B, Analytical technologies in the biomedical and life sciences*, ISSN 1570-0232, 2013, vol. 927, str. 80-89, graf. prikazi, doi: 10.1016/j.jchromb.2013.02.004. [COBISS.SI-ID 4263032]

ČERNIGOJ, Urh, VIDIC, Urška, BARUT, Miloš, PODGORNIK, Aleš, PETERKA, Matjaž, ŠTRANCAR, Aleš. A multimodal histamine ligand for chromatographic purification of plasmid DNA. *Journal of*

chromatography. A, ISSN 0021-9673, 2013, vol. 1281, str. 87-93, doi: 10.1016/j.chroma.2013.01.058. [COBISS.SI-ID 4263544]
PODGORNIK, Aleš, LENDERO KRAJNC, Nika. Application of monoliths for bioparticle isolation. *Journal of separation science*, ISSN 1615-9314, 2012, vol. 35, no. 22, str. 3059-3072, ilustr., doi: 10.1002/jssc.201200387. [COBISS.SI-ID 21235430]