UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	BIOPROCESNO INŽENIRSTVO
Course Title:	BIOPROCESS ENGINEERING

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

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: IN213

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: prof. dr. Polona Žnidaršič Plazl / Dr. Polona Žnidaršič Plazl, Full Professor

Jeziki / Languages:

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Študent oz. kandidat mora imeti predmet opredeljen kot študijsko obveznost.

Prerequisites:

The course has to be assigned to the student.

Vsebina:

-Pomen bioprocesnega inženirstva in biotehnologije. Razvoj bioprocesov: zgodovina proizvodnje penicilina.
- Struktura in delovanje celice. Raznolikost živega sveta. Mikrobiološke zbirke. Prenos snovi med celico in okolico. Hranila.
- Kinetika rasti celic. Nestrukturni in strukturni modeli rasti. Specifike rasti nitastih gliv.
- Načini vodenja bioprocesov. Šaržno gojenje, šaržno gojenje z dohranjevanjem. Kontinuirno gojenje, kemostat. Simulacije procesov.
- Biotransformacije. Imobilizacija encimov.
- Bioreaktorji. Instrumentacija in vodenje bioreaktorjev. Prenos toplote in snovi v

Content (Syllabus outline):

- The role of bioprocess engineering and biotechnology. Bioprocess development: a history of penicillin production.
- Characteristics of biological systems. The diversity of the living world. Microbial collections. Material exchange between cells and environment. Substrates.
- Cell growth kinetics. Unstructured and structured growth models. Specifics of growth of filamentous fungi.
- Bioprocess operation. Batch, fed-batch and continuous bioprocess simulations.
- Biotransformations. Enzyme immobilization.
- Bioreactors. Instrumentation and control. Heat

bioreaktorjih. - Pripravljalni in zaključni procesi. -Integrirani procesi. Mikroreaktorji in »lab on a chip« sistemi. Nekonvencionalni mediji. - Specifičnosti bioprocesov z živalskimi in rastlinskimi celicami. Uporaba bioinženirstva v medicini.	and mass transfer in bioreactors. - Upstream and downstream processes. -Integrated processes. Microreactors and "lab-on-a-chip" systems. Non-conventional media. - Bioprocesses with plant and animal cells. Bioengineering in medicine.

Temeljna literatura in viri / Readings:

Doran, P.M. Bioprocess Engineering Principles, 2nd Ed., Elsevier, Amsterdam [etc.], 2013. 919 p. (30 %)

Shuler, M.L., Kargi F. Bioprocess Engineering: Basic Concepts. 2nd Ed., Prentice Hall, Upper Saddle River, 2002. 553 p. (10 %)

Nielsen J., Villadsen J., Liden G. Bioreaction Engineering Principles, 2nd Ed. Kluwer Academic/ Plenum Press, New York, 2002. 456 p. (10 %)

Raspor, P. (ur.) Biotehnologija. Bia, d.o.o., Ljubljana. 1996. 815 p. (20 %)

Žnidaršič Plazl, P., Pavko, A. Praktikum iz biokemijskega inženirstva. Fakulteta za kemijo in kemijsko tehnologijo, Ljubljana. 2005. 89 p. (90 %)

Cilji in kompetence:	**Objectives and Competences:**
Cilj predmeta je, da se študentje naučijo uporabljati inženirske principe za analizo, načrtovanje in razvoj bioprocesov, pri čemer izhajajo iz znanj o molekularnih osnovah ved o življenju, termodinamike in kinetike. Študent si pri predmetu pridobi naslednje specifične kompetence: - sposobnost pridobivati in analizirati podatke za načrtovanje, spremljanje in nadzor bioprocesov - osvajanje nekaterih izbranih laboratorijskih tehnik: vodenje in analiza bioprocesa v laboratorijskem bioreaktorju, določanje koeficienta prenos kisika v kapljevino, mikrofiltracija	Objectives: To acquaint students to apply engineering principles to Student will advance the basic knowledge in life sciences from the engineering perspectives and gain the comprehension of specificities of the development, operation, performance and monitoring of processes with biocatalysts. Principles of enzyme function and mechanisms, as well as the use of whole cells as biocatalysts will be adopted., deriving from knowledge about the fundamental concepts of life sciences, thermodynamics and reaction kinetics. Students obtain the following specific competencies: - ability to obtain an analyze quantitative data necessary data development, monitoring and control of bioprocesses - Knowledge of some selected laboratory techniques: management and analysis of a bioprocess in a laboratory bioreactor, oxygen transfer coefficient determination, microfiltration

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

Znanje in razumevanje Študent nadgradi osnovna znanja iz ved o življenju z inženirskega vidika in osvoji specifičnosti vodenja in analize bioprocesov. Razume zakonitosti delovanja encimov in celic ter osnovne principe industrijskih bioprocesov.	Knowledge and Comprehension Student will advance the basic knowledge in life sciences from the engineering perspectives and gain the comprehension of specificities of the development, operation, performance and monitoring of bioprocesses. Principles of enzymes and cell function, and basics of industrial bioprocesses will be adopted.
Uporaba Pridobljena znanja je študent sposoben uporabljati pri razvoju, vodenju in analizi bioprocesov.	Application Student will be capable of using gained knowledge for development, analysis and control of bioprocesses.
Refleksija Študent bo interpretiral ter pred kolegi analiziral lastno razumevanje izbranih bioprocesov.	Analysis Student will interpret and analyse the knowledge on selected bioprocesses.
Prenosljive spretnosti Računalniška obdelava eksperimentalnih podatkov, uporabljanje spletnih virov, pisanje poročil, priprava računalniške predstavitve seminarja, timsko delo.	Skill-transference Ability Analysis of experimental data, the use of internet as a data source, writing of reports, a seminar preparation and oral presentation, team work.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Predavanja, projektno-tehnoloških študije – seminarji, praktične vaje.	Lectures, seminars, practical training.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Vaje: Oceno vaj sestavljajo sprotno preverjanje znanja in ocene poročil.	15 %	Practical training: Final grade consists of the preparation for the lab work and reports.
Seminarji	15 %	Seminars
Pisni in ustni izpit	70 %	Written and oral exam

Reference nosilca / Lecturer's references:

- NOVAK, Uroš, **ŽNIDARŠIČ PLAZL, Polona**. Integrated lipase-catalyzed isoamyl acetate synthesis in a miniaturized system with enzyme and ionic liquid recycle. *Green Processing and Synthesis*, 2013, 2, 561-568.
- STOJKOVIČ, Gorazd, **ŽNIDARŠIČ PLAZL, Polona**. Continuous synthesis of L-malic acid using whole-cell microreactor. *Process Biochemistry*, 2012, 47, 1102-1107.
- MARQUES, M. P. C., FERNANDES, P., CABRAL, Joaquim M. S., **ŽNIDARŠIČ PLAZL, Polona,** PLAZL, Igor. On the feasibility of *in-situ* steroid biotransformation and product recovery in microchannels. *The Chemical Engineering Journal*, 2010, 160, 708-714.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	BIOREAKTORSKO INŽENIRSTVO
Course Title:	BIOREACTOR ENGINEERING

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

Vrsta predmeta / Course Type: izbirni strokovni / Elective Professional

Univerzitetna koda predmeta / University Course Code: IN2I05

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: prof. dr. Polona Žnidaršič Plazl /
Dr. Polona Žnidaršič Plazl, Full Professor

Jeziki / Languages:

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Študent oz. kandidat mora imeti predmet opredeljen kot študijsko obveznost.

Prerequisites:

The course has to be assigned to the student.

Vsebina:

Temeljna vsebinska področja predmeta so: Transportni procesi v bioreaktorjih. Mešala v bioreaktorjih, načini mešanja aksialni in radialni, pnevmatski načini mešanja, mešanje z obtočnimi črpalkami. Fluidna dinamika in reologija bioprocesnih brozg. Tokovni modeli. Problematika snovnega in toplotnega prenosa v bioreaktorjih. Vrste bioreaktorjev z ozirom na uporabljeni substrat. Membranski bioreaktorji in bioreaktorji za sintezo posebnih produktov. Bioreaktorji velikih dimenzij za čiščenje odpadnih vod in bioreaktorji za anaerobne procese, fotobioreaktorji za kultivacijo rastlinskih tkivnih kultur in alg. Principi načrtovanja in izbire bioreaktorja. Povečevalni

Content (Syllabus outline):

Bioreactor design according to bioreactor design according to the type of microorganism or tissue culture, type of bioprocess and the mode of operation. Mass and heat transport processes, fluid dynamics, process rheology and the modes of operation in various types of bioreactors. Mixing principles and the impellers in bioreactors. Pneumatic mixing and circulation pumps. Liquid flow models. Heat and mass tranport in liquid substrates. Types of bioreactors. Membrane bioreacors and fine products bioreactors. Larged scale bioreactors. Photo bioreactors for plant cells and algae cultivations. Bioreactors for plant and mammal

(*scale-up*) in pomanjševalni procesi (*scale-down*). Fizikalni in biološki koncept povečevanja. Izbrani primeri prenosa bioprocesov v industrijsko merilo. Primerjava ekonomike obratovanja med različnimi vrstami bioreaktorjev. Vodenje bioprocesov z ozirom na izbiro vrste substrata in bioreaktorja: Šaržno obratovanje, kontinuirno obratovanje, obratovanje z reciklom, obratovanje z napajanjem substrata in perfuzijski način obratovanja. Bioprocesiranje na trdnih gojiščih. Bioprocesna analitika. *On-line, in-line* ter *off-line* meritve. Optični senzorji in biosenzorji. Procesno integrirani sistemi: Vzroki in načini za procesno integracijo in merila za izbiro sistema. Primeri integriranih bioprocesov.	cell cultivation. Solid state substrate bioreactors and bioreactor design. Bioreactors and bioprocesses scale-up. Principles of chemical engineering and metabolic aspects *scale-up*. Batch, fed batch, perfusion, continuous and chemostat principles and the modes of operation. Bioreactor o*n-line, in-line* and *off-line* instrumentation control. Optical and biosensors. Bioreactor case studies. Process integrated systems : the reasons and the selection principles for process integration. Examples of process integrated systems.

Temeljna literatura in viri / Readings:

- Mitchell, D.A., Berovic, M., Krieger, N., Solid-state fermentation bioreactors : fundamentals of design and operation. Springer Verlag, Berlin (2006) str.442, (20%)
- P.Doran,Bioprocess Engineering Principles, Acad. Press,(2012), str. 525 (30%)
- Berovic M., Nienow A., Bioprocess Engineering Principles, UL Press (2010), str.444)(50%)

Cilji in kompetence:	**Objectives and Competences:**
Cilj predmeta je spoznavanje študentov z osnovami delovanja, vodenja in načrtovanja bioreaktorjev, vseh inženirskih operacij procesa biosinteze in prenosa tehnologije iz laboratorijskega v industrijsko merilo, kar slušatelj spozna na praktičnih primerih. Predmet se povezuje z osnovnimi tehničnimi predmeti in naravoslovnimi predmeti kot so analitska kemija, biokemija, mikrobiologija in biotehnologija rastlinskih in živalskih kultur. Predmetno specifične kompetence: - sposobnost razumevanja in funkcionalnega povezovanja načrtovanja in obratovanja bioreaktorjev s potrebami tehnološkega procesa, mikrobne fiziologije in rekombinantnih tehnologij genskega inženiringa - spoznavanje in povezovanje delovanja	Capability and insight of the role and the relevance of basical engineering principles and applications in biotechnology. The focus of the study is to learn how to use engineering technology skills and applica tion in bioreactors in laboratory, pilot 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

bioreaktorja z osnovnimi operacijami kemijskega in biokemijskega inženirstva – prenosa toplote in snovi, bioprocesne reologije, mešanja z vodenjem in kontrolo bioprocesa. - spoznavanje vpliva mikrobne fiziologije na razvoj tehnološkega postopka od laboratorijskih raziskav do industrijskega postopka - uporaba bioreaktorjev z ozirom na zahteve industrijske biotehnologije	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:**
<u>Znanje in razumevanje</u> Razumevanje delovanja bioreaktorjev in njihove vloge v biotehnološkem procesu. Sposobnost vključevanja predhodno pridobljenih znanj kemijskega inženirstva z biotehnološkim procesom. Spoznavanje pomembnosti mikroorganizma kot glavnega akterja v tehnološkem procesu nastajanja bioproduktov in načrtovanja bioreaktorjev. Sposobnost povezovanja instrumentacije bioprocesov s sodobnimi principi meritev in regulacije.	<u>Knowledge and Comprehension</u> Understanding of the relevance and interdisciplinary structure of biotechnology. reactor design and operation according to the applied microbial culture, basic chemical and biochemical engineering principles and the modes of operation. Ability of comprehensive instrumentation and process control.
<u>Uporaba</u> Na osnovi pridobljenih osnovnih znanj študent spozna, delovanje in oblikovanje bioreaktorjev z ozirom na potrebe fiziologije mikrobnih celic in njihovo pridobivanja produktov visokotonažne, rekombinantne in fine biotehnologije.	<u>Application</u> Recognition of the relevance and the role of the operation and the bioreactor design related to microbial physiology and microbial cell structures and bioreactor design in operation in bulk, recombinant and fine product biotechnology.
<u>Refleksija</u> Refleksija lastnega razumevanja vloge povezovanja predhodno pridobljenih znanj biokemijskega inženirstva, mikrobiologije in mikrobne fiziologije in povezave teorije in prakse. Refleksija kritičnega vrednotenja skladnosti med teoretičnimi načeli in praktičnim ravnanjem.	<u>Analysis</u> Reflection of the role of basic biochemical engineering and microbiology knowledgement with theory and practice integration. Theoretical principles and practice consistency reflection. Reflection of critical evaluation of conformity between theoretical principles and practical behavior.
<u>Prenosljive spretnosti</u> Pridobivanje praktičnih tehnoloških znanj kot osnove za uspešno vodenje osnove uspešnega tehnološkega procesa biosinteze v bioreaktorjih. Študenti pridobijo osnovna tehnološka znanja za načrtovanje in uspešno	<u>Skill-transference Ability</u> Acquisition of practical technology skills as the basis for the successful conduct of successful bioprocess in various types of boreactors. The basic technology skills for planning and management of bioreactors from laboratory to

vodenje bioreaktorjev od laboratorijskega do industrijskega merila. Študent pridobi znanja v obliki predavanj, seminarjev in povezovanja teoretičnih znanj z pridobljenimi znanji iz strokovne literature.	industrial scale. 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.	Lectures, seminars, exercises

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni in ustni izpit	**70%**	Written and oral exam
Opravljene vaje so pogoj za pristop k izpitu.	**30%**	Accomplished laboratory practice is prerequisite to exam attendance**.**

Reference nosilca / Lecturer's references:

- **Žnidaršič Plazl, P**., Plazl, I. Microbioreactors. V: Moo-Young, M. (ur.). Comprehensive Biotechnology, 2nd Ed. Amsterdam [etc.]: Elsevier, 2011, str. 289-301. ISBN: 978-0-08-088504-9
- **Žnidaršič Plazl, P**. Enzymatic microreactors utilizing non-aqueous media. Chim. Oggi = Chem. Today, 2014, 32: 54-61
- 3. Novak, U., Lavric, D., **Žnidaršič Plazl, P**. Continuous lipase B-catalyzed isoamyl acetate synthesis in a two-liquid phase system using Corning□ AFRTM module coupled with a membrane separator enabling biocatalyst recycle. J. Flow Chem., 2016, 6: 33-38

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	BIOREMEDIACIJSKE TEHNOLOGIJE
Course Title:	BIOREMEDIATION TECHNOLOGIES

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

Vrsta predmeta / Course Type: izbirni strokovni / Elective Professional

Univerzitetna koda predmeta / University Course Code: IN2I11

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. Gabriela Kalčikova / Dr. Gabriela Kalčikova, Assistant Professor

Jeziki / Languages:

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Študent oz. kandidat mora imeti predmet opredeljen kot študijsko obveznost.

Prerequisites:

The course has to be assigned to the student.

Vsebina:

Uvod: definicije, terminologija, vrste onesnaženj, možnosti uporabe In-Situ in Ex-Situ bioremediacijskih procesov in tehnologij za sanacijo različnih vrst onesnaženj (tla, podtalnica, zrak) ter obdelavo industrijskih odpadkov, zakonodaja.
Bioremediacija: splošni mehanizmi, vplivi na proces, kinetika procesov, adaptacija organizmov, fitoremediacija, mikoremediacija, zooremediacija, kompostiranje, pregled in dimenzioniranje reaktorjev za izvedbo procesov.
Remediacija: pregled pristopov, vplivi na proces, primerjava z bioremediacijskimi tehnikami.

Content (Syllabus outline):

Introduction: definitions, terminology, types of pollution, feasibility of In-Situ and Ex-Situ bioremediation processes and technologies for treatment of different types of pollution (soil, groundwater, air) and industrial wastes, legislation.

Bioremediation: mechanisms, impacts, factors, kinetics of the processes, adaptation of organisms, phytoremediation, mycoremediation, zooremediation, composting, overview and dimensioning of reactors for bioremediation.

Remediation: overview of different approaches, factors, impacts, comparison to bioremediation techniques.

Uporaba bioremediacijskih procesov za specifične vrste onesnaženj: kovine, organska onesnaževala, topila, pesticidi, farmacevtske učinkovine, plastika, PAHi in PCB. Izbrani primeri uporabe bioremediacijskih tehnologij	**Application of bioremediation for particular types of pollution:** metals, organic pollutants, solvents, pesticides, pharmaceuticals, PAHs, PCBs. Selected bioremediation technologies: Case studies.

Temeljna literatura in viri / Readings:

- Biodegradation and Bioremediation, M.Alexander, Academic Press, 1999, 453 str. (30%)
- Renewables-based technology: sustainabilizy assesment, J.Dewulf and H. Van Langenhove, John Wiley and Sons, 2006, 339 str. (30%)

Cilji in kompetence:	**Objectives and Competences:**
Slušatelj spozna vrste polutantov glede na sestavo, strukturo in lastnosti in postopke za njihovo biorazgradnjo. To mu omogoča naslednje kompetence: - poznavanje oziroma klasifikacijo polutantov, - poznavanje primernih postopkov za njihovo odstranjevanje, - sposobnost izbire primerne naprave oziroma tehnologije za odstranjevanje določene izbrane snovi, - sposobnost izbire odgovarjajočih obratovalnih parametrov ter njihovega optimiranja, - sposobnost opravljanja raziskav na tem področju in vodenja procesa v industrijskem merilu, - sposobnost razumevanja in povezovanja bioremediacije z drugimi tehnikami in znanji pri zaščiti in varovanju okolja.	Recognizing types of pollutants regarding their chemical composition, structure and basic principles of their removal. This allows: - ability to classify the pollutants, - evaluation of suitable processes for their removal, selection of equipment and technology as well as process parameters,ability to perform research work in this field in a laboratory and industrial scale, - ability to understand and include bioremediation into other techniques for environmental protection.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
<u>Znanje in razumevanje</u> Študent pridobi znanja o vrstah polutantov, vrstah postopkov za njihovo odstranjevanje in izbiri primerne naprave oziroma tehnologije. To mu omogoča analizo določene problematike in sintezo znanj pri njenem reševanju: zna opredeliti nalogo in jo rešiti na teoretskem in praktičnem nivoju.	<u>Knowledge and Comprehension</u> Student learns about the types of pollutants, types of processes for their removal and selection of a suitable equipment and technology. This allows the analysis of a particular problem and synthesis of knowledge for its solution: he knows how to define the problem and how to solve it on a theoretical and practical level.
<u>Uporaba</u> S pridobljenim znanjem je študent sposoben za izbran polutant izbrati primeren proces skupaj z obratovalnimi pogoji bodisi v	<u>Application</u> With the acquired knowledge student is able to select a suitable process together with operating conditions on a laboratory scale for

laboratorijskem merilu za raziskovalne namene ali pa v industrijskem merilu za proizvodno tehnologijo.	research purposes as well on an industrial scale for a process technology for a particular pollutant.
Refleksija Na osnovi pridobljenega teoretičnega znanja in praktične vaje študent pridobi občutek za ovrednotenje podatkov in prenos znanja v raziskovalni in/ali tehnološki proces.	Analysis On the basis of acquired theoretical and practical knowledge, student gets the feeling for data evaluation and knowledge transfer to the research and/or industrial process.
Prenosljive spretnosti Uporaba različnih literaturnih virov (knjige, članki, elektronsko gradivo) omogoča zbiranje podatkov oziroma vrednotenje lastnih rezultatov in njihovo interpretacijo ter preverjanje pravilnosti. Končni rezultat je boljše razumevanje proučevanega procesa. Hkrati se razvijajo sposobnosti za vključevanje v skupinsko delo, komunikacijo in pripravo pisnega materiala.	Skill-transference Ability Use of various literature sources (books, papers, electronic data) enables data collection and evaluation of own results, their interpretation and correctness control. The final result is a better understanding of the process. Skills for a team work, communication and written report preparation are simultaneously developed.

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

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni in ustni izpit	**70**	Written and oral exam.
Zaključena seminarska naloga (projektno delo)	**20**	Accomplished project work.
Opravljene obveznosti pri vajah	**10**	Accomplished lab course.

Reference nosilca / Lecturer's references:

KALČÍKOVÁ, Gabriela, BABIČ, Janja, PAVKO, Aleksander, ŽGAJNAR GOTVAJN, Andreja. Fungal and enzymatic treatment of mature municipal landfill leachate. *Waste management*, ISSN 0956-053X. 2014, vol. 34, no. 4, str. 798-803

KALČÍKOVÁ, Gabriela, ZUPANČIČ, Marija, JEMEC KOKALJ, Anita, ŽGAJNAR GOTVAJN, Andreja. The impact of humic acid on chromium phytoextraction by aquatic macrophyte Lemna minor. *Chemosphere*, ISSN 0045-6535. 2016, vol. 147, str. 311-317

ŽGAJNAR GOTVAJN, Andreja, KALČÍKOVÁ, Gabriela. Delamination of plastic-coated waste paper by enzymes of the white rot fungus Dichomitus squalens. *Journal of environmental management*, ISSN 0301-4797, Dec. 2018, vol. 228, str. 165-168

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	BIOTRANSFORMACIJE
Course Title:	BIOTRANSFORMATIONS

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

Vrsta predmeta / Course Type: izbirni strokovni / Elective Professional

Univerzitetna koda predmeta / University Course Code: IN2I12

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: prof. dr. Polona Žnidaršič Plazl /
Dr. Polona Žnidaršič Plazl, 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):
Temeljna vsebinska področja predmeta so: - uvod v encimsko tehnologijo in biotransformacije, encimi, mikroorganizmi kot biokatalizatorji; - kinetika encimsko kataliziranih reakcij, stabilnost encimov, izboljšanje encimov; - proizvodnja in izolacija encimov, encimi v organski kemiji, uporaba encimov v raztopinah; - imobilizacija encimov, imobilizacija mikroorganizmov in celic; specifični reaktorji - karakterizacija imobiliziranih biokatalizatorjev, prenos snovi in reakcija, določanje kinetike imobiliziranih biokatalizatorjev;	The primary subject areas of the course are: - Introduction to enzyme technology and biotransformations, enzymes, microorganisms as biocatalysts; - Kinetics of enzyme catalyzed reactions, enzyme stability, improvement of enzymes; - The production and isolation of enzymes, enzymes in organic chemistry, the use of enzymes in solution; - Immobilization of enzymes, immobilization of microorganisms and cells; specific reactors - Characterization of immobilized biocatalysts, mass transfer and reaction, kinetic characterization of immobilized biocatalysts; - Selected examples of industrial

- izbrani primeri industrijskih biotransformacij - integrirani procesi biotransformacij, biotransformacije v mikroreaktorjih, biotransformacije v nekonvencionalnih medijih	biotransformations - An integrated bioprocesses, biotransformations in microreactors, biotransformations in non-conventional media

Temeljna literatura in viri / Readings:

- Buchholz, K., Kasche, V., Bornscheuer, U.T. Biocatalysts and Enzyme Technology, 2nd Edition. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim. 2012. 626 str. (70%)
- Liese, A., Seelbach, K., Wandrey, C. Industrial Biotransformations. Wiley-VCH Verlag GmbH & Co. KGaA, 2005. (20 %)
- Žnidaršič Plazl, P., Podgornik, H. Vaje iz biotehnologije, 2. Izd. Fakulteta za kemijo in kemijsko tehnologijo, Ljubljana. 2011. 96 p. (15 %)

Cilji in kompetence:	**Objectives and Competences:**
Cilj predmeta je seznaniti študente z možnostmi uporabe biotransformacij z encimi ali celotnimi celicami v industriji, razvijati zavest o pomenu biotransformacij pri načrtovanju okoljsko sprejemljivih procesov in uporabljati inženirske principe za analizo, načrtovanje in razvoj procesov z biokatalizatorji, pri čemer izhajajo iz znanj o molekularnih osnovah ved o življenju ter termodinamike in kinetike reakcije. Študent si pri predmetu pridobi naslednje specifične kompetence: - poznavanje uporabe biotransformacij v industrijskih procesih, kmetijstvu in okoljevarstvu - razumevanje delovanja biokatalizatorjev (celic/encimov) z inženirskega vidika - sposobnost pridobivanja potrebnih podatkov za izračune v biokemijskem inženirstvu - sposobnost analiziranja bioloških dejavnikov, ki so pomembni za načrtovanje, delovanje, obnašanje in spremljanje procesov z biokatalizatorji - osvajanje nekaterih izbranih laboratorijskih tehnik: vodenje in analiza procesa biotransformacije v laboratorijskem merilu, analiza encimske kinetike v mikroreaktorju	Objectives: To acquaint students with the opportunities to use biotransformations with enzymes or whole cells in the industry, to develop an awareness of the importance of biotransformations in the planning of environmentally acceptable processes and to apply engineering principles to the analysis, design and development of processes with biocatalysts, deriving from knowledge about the fundamental concepts of life sciences, biotransformation thermodynamics and reaction kinetics. Students obtain the following specific competencies: - Knowledge of the use of biotransformations in industrial processes, agriculture and environmental engineering - Understanding of biocatalysts (cells / enzymes) from the engineering point of view - Ability to obtain necessary data for calculations in biochemical engineering - The ability to analyze the biological factors that are important for the planning, operation, performance and monitoring of processes with biocatalysts - Bring in some selected laboratory techniques: management and analysis of the process of biotransformation at the laboratory-scale, analysis of enzyme kinetics in a microreactor

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
<u>Znanje in razumevanje</u> Študent nadgradi osnovna znanja iz ved o	<u>Knowledge and Comprehension</u> Student will advance the basic knowledge in life

življenju z inženirskega vidika in osvoji specifičnosti načrtovanja, vodenja in analize procesov z biokatalizatorji. Razume zakonitosti delovanja encimov oz. celic kot biokatalizatorjev, kar omogoča razumevanje njihove uporabe v biotehnologiji.	sciences from the engineering perspectives and gain the comprehension of specificities of the development, operation, performance and monitoring of processes with biocatalysts. Principles of enzyme function and mechanisms, as well as the use of whole cells as biocatalysts will be adopted.
Uporaba Pridobljena znanja je študent sposoben uporabljati pri razvijanju, vodenju in analizi procesov z biokatalizatorji.	Application Student will develop the ability to participate in the development, control and analysis of processes with biocatalysts.
Refleksija Študent bo interpretiral ter pred kolegi analiziral lastno razumevanje izbranih procesov biotransformacij. Pri tem bo uporabil pridobljena teoretična znanja ter jih vrednotil s praktičnimi izkušnjami.	Analysis Student will interpret and analyse the knowledge on selected biocatalytic processes.
Prenosljive spretnosti Računalniška obdelava eksperimentalnih podatkov, uporabljanje spletnih virov, pisanje poročil, priprava računalniške predstavitve seminarja, timsko delo	Skill-transference Ability Analysis of experimental data, the use of internet as a data source, writing of reports, a seminar preparation and oral presentation, team work.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Predavanja, laboratorijske vaje, individualno in skupinsko delo pri pripravi seminarjev. Spletna gradiva za določena poglavja.	Lectures, seminars, practical training.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Vaje: Oceno vaj sestavljajo sprotno preverjanje znanja in ocene poročil. 15% Seminarji 15% Pisni in ustni izpit 70%		

Reference nosilca / Lecturer's references:

- ŽNIDARŠIČ PLAZL, Polona. Enzymatic microreactors utilizing non-aqueous media. *Chimica Oggi – Chem. Today,* 2014, 32, 54-61.

- STOJKOVIČ, Gorazd, PLAZL, Igor, **ŽNIDARŠIČ PLAZL, Polona**. L-Malic acid production within a microreactor with surface immobilised fumarase. *Microfluidics and Nanofluidics*, 2011, 10, 627-635.

- POHAR, Andrej, PLAZL, Igor, **ŽNIDARŠIČ PLAZL, Polona.** Lipase-catalyzed synthesis of isoamyl acetate in an ionic liquid/*n*-heptane two-phase system at the microreactor scale. *Lab on a Chip*, 2009, 9, 3385-3390.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	INDUSTRIJSKA EKOLOGIJA IN ČISTEJŠA PROIZVODNJA
Course Title:	INDUSTRIAL ECOLOGY AND CLEAN TECHNOLOGY

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

Vrsta predmeta / Course Type: izbirni strokovni / Elective Professional

Univerzitetna koda predmeta / University Course Code: IN2I02

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. Andreja Žgajnar Gotvajn /
Dr. Andreja Žgajnar Gotvajn, 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):
Industrijska ekologija: definicija, vzporednice med industrijskim procesom in biološkimi sistemi, povezava industrijskih sistemov z naravo in človekom, etika in družbene posledice industrijske proizvodnje in inženirskih odločitev, čistejša proizvodnja kot aplikacija industrijske ekologije v praksi za izboljšanje materialnih in energijskih izkoristkov, pomen celovitega pristopa. Inženirska orodja industrijske ekologije: preprečevanje onesnaženja, eko-učinkovitost, čistejša proizvodnja, koncept minimizacije, zamenjava surovin, uporaba sekundarnih	Industrial Ecology: definitions, comparison of industrial and natural processes, impacts of industrial processes on the ecosystem and mankind, ethics of industrial production, ethics and social consequences of technical decisions, cleaner production as application of industrial ecology for better resource and energy use, importance of complex approach for solving environmental problems. Tools for achieving goals of industrial ecology: pollution prevention techniques, eco-efficiency, cleaner production, minimisation concepts, use of secondary renewable raw materials (water

obnovljivih surovin (recikliranje, ponovna uporaba odpadnih vod, priprava površinskih vod za industrijsko izrabo, razsoljevanje, recikliranje kovin, bioplastika) in virov energije (biogoriva, solarna energija in energija vetra, bioplin), optimizacija procesov, inovativne in zelene tehnologije (sonokemijski, fotokemijski in elektrokemijski procesi, uporaba membranskih tehnik), sodobni materiali v tehnikah za varstvo okolja, trendi razvoja reaktorjev, uporaba multifunkcijskih enot, zelena topila, zaprti krogotoki v procesih, koncept proizvodnje brez odpadkov, zakonodaja. Optimizacija industrijskega procesa: integrirana strategija preventive, pregled LCA (Life Cycle Assessment) modelov in pristopov k postavitvi mej ter ciljev LCA analize, posledice vključitve različnih metod recikliranja in ekonomskih odločitev v LCA model. Ekooptimizacija proizvodnega procesa in produkta, vrednotenje zmanjšanja vpliva na okolje kot posledica vpeljave sprememb, učinkovit transport, vodenje in nadzor, vključevanje lokalne in širše skupnosti, globalen pristop, koncept trajnosti. Uporaba koncepta industrijske ekologije na primeru: primer industrije ali izdelka, relevanten času in slovenskemu prostoru.	reuse and recycling, pretretament of surface waters for industrial purposes, desalination, recycling of metals, bioplastics) and energy (biofuels, solar and wind energy, biogas) optimisation of processes, innovative and green technologies (sonochemistry, photochemistry and electrochemistry, membrane techniques), advanced materials in environmental technologies, trends in reactor development, multi-functional units, green solvents, implementation of closed-loop systems, zero waste management, legislation. Industrial Ecology Approach: integrated pollution prevention strategies, overview of LCA (Life Cycle Assessment) models and approaches for setting up limits and goals of LCA, consequences of incorporation of different recycling methods and economical decision in LCA model. Eco-optimization of products and processes, evaluation of reduction of environmental impact due to implemented changes, effective transportation, management and importance of local and global society responses, sustainability concept. Implementation of concept of industrial ecology: A case study with product or process relevant in time and place.

Temeljna literatura in viri / Readings:

T.E. Greadel, B.R. Allenby: Industrial Ecology, 2nd Ed., Prentice Hall, 2003, 363 pages (30%).
A.R. Braden, D.J. Richards: The Greening of Industrial Ecosystems, National Academy Press, 1994, 253 pages (30%).
V. Piemonte, M. De Falco, A. Basile: Sustainable Development of Chemical Engineering Innovative Technologies, Wiley and Sons, 2013, 349 pages (40%).

Dodatna literatura.

J. Zagorc-Končan, A. Žgajnar Gotvajn: Zbirka nalog iz ekološkega inženirstva, UL, FKKT, 2008, 45 pages.

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

Zavedanje, da industrijskega procesa ne moremo izvzeti iz njegove okolice. Znanje za načrtovanje čistejše proizvodnje v obstoječi ali na novo načrtovani proizvodnji v različnih industrijskih branžah. Zavedanje o etični odgovornosti in potrebi po nenehnem izpopolnjevanju že postavljenega sistema. Kompetence: Poznavanje pomena industrijske ekologije za čistejšo proizvodnjo, okolje in ljudi. Poznavanje orodij in njihova uporaba za dosego teh ciljev. Sposobnost samostojne vpeljave koncepta čistejše proizvodnje.	Awareness on the impacts of incorporating industrial processes into environment. Knowledge on tools and their application necessary for achieving and implementing cleaner production in new and existing indistrial systems. Awareness of ethical responsibility and need for constant improvement of the system. Competences: Awareness on the importance of industrial ecology for cleaner production, environment and people. Knowledge on tools, design and implementation of cleaner production concepts Ability to implement the concept of cleaner production.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
<u>Znanje in razumevanje</u> Razumevanje povezav in odnosov med osvojenimi pojmi. Sposobnost vrednotenja vpliva procesov na ljudi in okolje. Znanje za izvedbo LCA in vpeljavo koncepta industrijske ekologije v obstoječ ali nov industrijski proces	<u>Knowledge and Comprehension</u> Understanding relationships between different terms. Ability to evaluate the impact of processes to environment and people. Knowledge on LCA performance. Ability to implement the concept of cleaner production into new or existing industrial process.
<u>Uporaba</u> Uporaba pridobljenih znanj pri reševanju kompleksnih inženirskih problemov. Sposobnost sinteze in interdisciplinarnega pristopa k reševanju problemov.	<u>Application</u> Ability of applying acquired knowledge for solving more complex engineering problems. Ability of interdisciplinary approach when solving of problems.
<u>Refleksija</u> Razumeti pomen izbire ustreznih tehnoloških postopkov in surovin za ohranjanje naravnih virov. Kritično vrednotiti vpliv svojega dela na lokalni in globalni ravni. Zavedanje o družbenem vplivu svojih odločitev.	<u>Analysis</u> Understand the importance of selection of appropriate technologies and raw materials to protect natural resources. Evaluate the work critically on local as well as global basis. Awareness on environmental, economical and ethical consequences of technical decisions.
<u>Prenosljive spretnosti</u> Spretnost uporabe domače in tuje literature. -Spretnost identifikacije problema in pristopa k njegovemu učinkovitemu reševanju. Uporaba ustnega in pisnega načina poročanja. Spretnost sinteze na različnih področjih pridobljenih znanj.	<u>Skill-transference Ability</u> Ability to search, select and apply different types of literature. Ability to independently identify various environmental problems and search for solution including broad multidisciplinary approach. Development of oral and literate skills.

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

- Predavanja - Seminarsko delo - Projektno delo	Lectures Lab course Project work

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Opravljene obveznosti pri vajah.	**20%**	Accomplished lab course.
Pisni in ustni izpit.	**50%**	Written and oral exam.
Zaključena seminarska naloga (projektno delo).	**30%**	Accomplished project work.

Reference nosilca / Lecturer's references:

- **ŽGAJNAR GOTVAJN, Andreja**, BISTAN, Mirjana, TIŠLER, Tatjana, ENGLANDE, A. J., ZAGORC-KONČAN, Jana. The relevance of bisphenol A adsorption during Fenton's oxidation. *International journal of environmental science and technology*, ISSN 1735-1472, 2013, vol. 10, no. 6, str. 1141-1148.
- DERCO, Ján, **ŽGAJNAR GOTVAJN, Andreja**, MENCÁKOVÁ, Angelika. Oxidative treatment of landfill leachate. V: CABRAL, Gustavo B. C. (ur.), BOTELHO, Beatriz A. E. (ur.). *Landfills : waste management, regional practices and environmental impact*, (Waste and waste management). New York: Nova Science, cop. 2012, str. 1-82.
- **ŽGAJNAR GOTVAJN, Andreja**, ZAGORC-KONČAN, Jana, TIŠLER, Tatjana. Pretreatment of highly polluted pharmaceutical waste broth by wet air oxidation. *Journal of environmental engineering*, ISSN 0733-9372, 2007, vol. 133, no. 1, str. 89-94.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	INŽENIRSTVO MATERIALOV
Course Title:	ENGINEERING OF MATERIALS

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

Vrsta predmeta / Course Type: izbirni strokovni / Elective Professional

Univerzitetna koda predmeta / University Course Code: IN2I04

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

Nosilec predmeta / Lecturer: Izr. prof. dr. Marjan Marinšek / Dr. Marjan Marinšek, 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):
Razvoj sodobnih materialov zahteva od inženirja poznavanje področja vede o materialih. Na osnovi znanj vede o materialih bo inženirstvo materialov predstavljeno na način soodvisnosti priprave-strukture-lastnosti-kvalitete materiala. Predstavljeno bo inženirstvo izbranih in aktualnih materialov ter njihova praktična uporabnost. Težišče bo usmerjeno v: • Inženirstvo kovinskih materialov: priprava izbranih kovinskih materialov; oblikovanje; toplotna in mehanska obdelava; kovinski prahovi, praškovna metalurgija, razvoj	Development of advanced materials requests from an engineer the knowledge of basic principles of materials science. Based on materials science the principle of materials engineering will be discussed in terms of processing-structure-properties-performance relationships. The engineering and practical application of selected materials will be presented and discussed. Focus will be given to: • Engineering of Metals: manufacturing of metallic materials, shaping, heat and mechanical treatment of metals,

jekel, specialne zlitine in njihove lastnosti • Inženirstvo keramike in stekel: oblikovanje keramičnih surovcev, sintranje, modifikacija keramičnih površin, zvišanje žilavosti keramike, razvoj inženirske keramike, perovskitna keramika • Inženirstvo polimernih materialov: oblikovanje polimernih izdelkov, recikliranje polimerov, razvoj polimernih materialov, specialni polimerni materiali • Inženirstvo kompozitnih materialov: razvoj betonov, specialni kompozitni materiali	powder metallurgy, development of steel, special alloys and their properties • Engineering of Ceramics and Glasses: green body shaping, sintering, modification of ceramic surfaces, toughening of ceramics, development of engineering ceramics, perovskites • Engineering of Polymers: polymer processing techniques, recyclability of polymers, development of polymers, special polymers • Engineering of Composites: development of concrete, special composites

Temeljna literatura in viri / Readings:

1. The Principles of Materials Selection for Engineering Design, Pat L. Mangonon, Prentice Hall, 1999, 824 strani (50%)
2. Engineering Materials 2, An Introduction to Microstructures and Processing, 4th ed. M.F. Ashby, D.R.H. Jones, Elsevier, 2013, 553 strani (20%)
3. Engineering Design with Polymers and Composites 2nd ed. , J.C. Gerdeen, H.W. Lord, R.A.L. Rorrer, Taylor&Francis Group (CRC), 2011, 349 strani, (10%)
4. Nanostructures and Nanomaterials, Synthesis, Properties and Applications, 2nd ed., Guozhong Cao, Ying Wang, World Scientific, 2011, 581 strani (20%)

Cilji in kompetence:	**Objectives and Competences:**
Načrtovanje materialov s specifičnimi lastnostmi, korelacija med procesom za pripravo materiala, dobljenimi karakteristikami in njihovo uporabnostjo.	Designing materials with specific properties, correlation between the materials preparation process, resulting characteristics and material applications.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
<u>Znanje in razumevanje</u> Študent spozna osnovne principe o lastnostih materialov; kako so odvisni od mikrostrukture, kako se spreminjajo s pripravo, kako korozija spreminja (skrajša) čas uporabe in kako so komponente kompatibilne z drugimi materiali v kompleksnih strukturah.	<u>Knowledge and Comprehension</u> Students understand the relations of materials properties and microstructure, how processing parameters change the properties and how the corrosion influences material's applicability
<u>Uporaba</u> Načrtovanje materialov s specifičnimi lastnostmi, izbor procesa za doseganje takega cilja.	<u>Application</u> Design of materials with specific properties, selection of processing route to obtain requested properties.
<u>Refleksija</u> Študenta znanja pridobljena v predhodnih študijskih letih uporablja za analizo	<u>Analysis</u> Students will integrate knowledge acquired in previous years to analyse complex problems in

kompleksnih problemov pri načrtovanju novih materialov ali takih s specifičnimi karakteristikami.	design of new materials or materials with specific properties.
Prenosljive spretnosti Razvita sposobnost kritičnega razmišljanja in logičnega sklepanja. Sposobnost študija domače in tuje literature ter predstavitve rezultatov.	Skill-transference Ability Ability of critical thinking and deduction; Ability of studying relevant literature from the field of materials processing and ability of clear presentation to public.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Predavanja, seminar, priprava seminarja.	

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni in ustni izpit	50%	Written and oral exam
Seminar	50%	Seminar

Reference nosilca / Lecturer's references:

1. ZUPAN, Klementina, **MARINŠEK, Marjan**, PEJOVNIK, Stane, MAČEK, Jadran, ZORE, Karmen. Combustion synthesis and the influence of precursor packing on the sintering properties of LCC nanopowders. Journal of the European ceramic society, ISSN 0955-2219. [Print ed.], 2004, vol. 24, no. 6, str. 1935-1939
2. DIMITROVSKA-LAZOVA, Sandra, KOVACHEVA, D., ALEKSOVSKA, Slobotka, **MARINŠEK, Marjan**, TZVETKOV, P. Synthesis and structural details of perovskites within the series PrCo[sub](1-x)Cr[sub]xO[sub]3 : (x = 0, 0.33, 0.67 and 1). Bulgarian Chemical Communications, 2012, vol. 44, no. 1, str. 37-46
3. CRNJAK OREL, Zorica, MAČEK, Jadran, **MARINŠEK, Marjan**, PEJOVNIK, Stane. Coprecipitation of copper/zinc compounds in metal salt-urea-water system. V: MAČEK, Marjeta (ur.), SUVOROV, Danilo. Refereed reports of IX Conference & Exhibition of the European Ceramic Society : 19-23 June 2005, Portorož, Slovenia, (Journal of the European ceramic society, vol. 27, no. 2-3, 2007). Amsterdam: Elsevier, 2007, vol. 27, no. 2/3, str. 451-455

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	KATALIZA IN HETEROGENI REAKCIJSKI SISTEMI
Course Title:	CATALYSIS AND HETEROGENEOUS REACTION SYSTEMS

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

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: IN211

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. Matjaž Krajnc / Dr. Matjaž Krajnc, Full Professor

Jeziki / Languages:

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Študent oz. kandidat mora imeti predmet opredeljen kot študijsko obveznost.

Prerequisites:

The course has to be assigned to the student.

Vsebina:

- Mehanizmi reakcij na površini trdnega katalizatorja. Kinetika reakcij na površini. Teorija prehodnega stanja površinskih reakcij. Reaktivnost površine.
- Karakterizacija trdnih katalizatorjev. Katalizatorji v farmacevtski in petrokemični industriji ter katalizatorji v procesih varstva okolja.
- Transport snovi in toplote na površino trdnega katalizatorja,
- Transport snovi in toplote znotraj poroznega katalizatorja. Efektivnostni faktor in globalna hitrost reakcije.
- Eksperimentalno določanja kinetičnih enačb za katalitske reakcije.
- Analiza in načrtovanje reaktorjev za katalitske

Content (Syllabus outline):

- Reaction mechanisms on the surface of solid catalysts. Reaction kinetics on the surface. Theory of the transition state of surface reactions.
- Characterization of solid catalysts. Catalysts in pharmaceutical and petrochemical industries and catalysts in the processes of environmental protection.
- Heat and mass transfer to the surface of solid catalyst,
- Heat and mass transfer within a porous catalyst. Effectiveness factor and global rate of reaction.
- Experimental determination of kinetic equations for catalytic reactions.
- Analysis and design of reactors for catalytic reactions. Pseudo-homogenous and heterogeneous models. Fixed-bed reactor.

reakcije. Psevdo-homogeni in heterogeni modeli. Reaktor s strnjenim slojem. Kapalni reaktor. Reaktor z goščo. Reaktor s fluidiziranim slojem. Adiabatni reaktor s strnjenim slojem in stabilno obratovanje. - Heterogene nekataliske reakcije. Reakcija v sistemu kapljevina-kapljevina in kapljevina-trdno. Reakcija v sistemu plin-kapljevina. Načrtovanje reaktorjev za nekatalitske heterogene reakcije.	Trickle-bed reactor. Slurry reactor. Fluidized-bed reactor. Fixed-bed adiabatic reactor and stable operation. - Heterogeneous non-catalytic reactions. Reactions in fluid-fluid, fluid-solid, and gas-fluid systems. Designing reactors for non-catalytic heterogeneous reactions.

Temeljna literatura in viri / Readings:

- G.F. Froment and K. B. Bischoff, Chemical Reactor Analysis and Design, 2. izdaja, Wiley, 1990, 661 strani (70 %)
- I. Chorkendorff and J.W. Niemantsverdriet, Concept of Modern Catalysis, 2. izdaja, Wiley-VCH Verlag, 2007, 457 stani (30 %)

Cilji in kompetence:	**Objectives and Competences:**
Predmet študentu razvija sposobnost analize in sinteze kompleksnih procesov s snovno pretvorbo (reakcijo). Predmet je nadaljevanje predmeta Kemijsko reakcijsko inženirstvo in ponuja znanja, ki so potrebna pri obravnavanje in načrtovanju procesov ter reaktorjev, v katerih potekajo reakcije z več fazami. Specifične kompetence predmeta so: - poznavanje, razumevanje in uporaba zakonov o ohranitvi mase, energije in gibalne količine, ko se kemijske pretvorbe odvijajo v večfaznem sistemu. - poznavanje, razumevanje in uporaba matematičnih zapisov hitrosti kemijskih pretvorb v heterogenih sistemih, - poznavanje in uporaba zvez med transportom toplote in snovi med fazami ter hitrostjo zginevanja snovi na površini katalizatorja, - poznavanje in uporaba zvez med notranjim transportom in hitrostjo reakcije znotraj poroznega katalizatorja	Developing competences for carrying out analysis and synthesis of complex reaction processes. The course is a follow-up to the Chemical reaction engineering course and provides the knowledge that is necessary for planning and designing processes in multi-phase reactors. Subject-specific competences include: - understanding and applying the laws of mass preservation, energy, and momentum when chemical changes occur in multi-phase systems, - understanding and applying mathematical descriptions of the rate of chemical changes in heterogeneous systems, - understanding and applying correlations of heat and mass transfer between the phases and the rate of mass disappearance at the catalyst surface, - understanding and applying correlations between internal transport and the rate of reaction within a porous catalyst.

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 vendar na molekularni skali. Razume, da le	<u>Knowledge and Comprehension</u> Student becomes aware of fundamental principles of formulating the rate laws on the molecular level within the infinitesimal reactor volume. He understands that the integration over the whole

integracija po prostoru reaktorja daje zvezo med obratovalnimi pogoji in dobitkom na makro skali.	reactor space provides the performance equation(s), which relates the operational conditions to the reactor yield.
Uporaba Ta znanja mu omogočajo analizo obratovanja obstoječih in načrtovanje novih reaktorjev za vodenje enostavnih reakcij in reakcij v sistemu z več fazami.	Application Possessing sufficient fundamental knowledge student can analyze the operation of simple existing reactors and understand the design of a new one.
Refleksija Študent je sposoben povezati 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, je ta sposobnost potrebna tudi za komuniciranje/sodelovanje z drugimi tehniškimi strokovnjaki.	Analysis Student is capable of using the knowledge of chemical kinetics and transport phenomena to formulate the reactor model and thus obtain a deeper insight on the processes on micro as well as macro reactor scale. This ability is also appreciated for communication and cooperation with materials and other engineering professionals.
Prenosljive spretnosti Študent je usposobljen tako za eksperimentalno delo na področju katalitskih procesov kot za strokovno 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 heterogene reakcijske sisteme.	Skill-transference Ability Developed skills of integrating fundamental chemical and engineering knowledge into processes that are taking place within a multiphase chemical reactor.

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

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

Reference nosilca / Lecturer's references:

RUČIGAJ, Aleš, **KRAJNC, Matjaž**. Kinetic modeling of a crude DERA lysate-catalyzed process in synthesis of statin intermediates. The chemical engineering journal, ISSN 1385-8947. [Print ed.], 2015, vol 259, no. 1, str. 11-24 [COBISS.SI-ID 1752623]

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**. Kinetic modeling of the peroxide cross-linking of polymers : from a theoretical model framework to its application for a complex polymer system. Chemical engineering and processing, ISSN 0255-2701. [Print ed.], 2011, vol. 50, no. 2, str. 200-210

[COBISS.SI-ID 35022597],

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],

KRAJNC, Matjaž, LEVEC, Janez. Oxidation of phenol over a transition-metal oxide catalyst in supercritical water. Industrial & engineering chemistry research, ISSN 0888-5885. [Print ed.], 1997, vol. 36, no. 9, str. 3439-3445 [COBISS.SI-ID 833562]

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	KEMIJA IN TEHNOLOGIJA KERAMIKE IN SILIKATOV
Course Title:	CHEMISTRY AND TECHNOLOGY OF CERAMICS AND SILICATES

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

Vrsta predmeta / Course Type: izbirni strokovni / Elective Professional

Univerzitetna koda predmeta / University Course Code: IN2I08

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

Nosilec predmeta / Lecturer: Izr. prof. dr. Marjan Marinšek /
Dr. Marjan Marinšek, Associate Professor

Jeziki / Languages:

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Študent oz. kandidat mora imeti predmet opredeljen kot študijsko obveznost.

Prerequisites:

The course has to be assigned to the student.

Vsebina:

Keramika:
Ponovitev osnov, kristalografske značilnosti in osnovne strukture, visokotemperaturna fazna ravnovesja, reakcijska kinetika, sintranje, razvoj mikrostrukture, proizvodne tehnologije, inžinirska in elektronska keramika, kompoziti, , biokeramika, sodobni keramični materiali in nanotehnologije
Stekla:
zgodovinski pregled stekel, Evansova, Zachariasnova in Goldschmitova teorija, struktura stekla, strukturni elementi, nukleacija in kristalizacija, ločevanje v faze, viskoznost in površinska napetost, optične in mehanske lastnosti, vrste stekel, tehnologije

Content (Syllabus outline):

Ceramics:
Revision of fundamentals, crystallographic properties and basic structures, high-temperature phase equilibria, reaction kinetics, development of the microstructure, production technologies, engineering and electronic ceramics, composites, bioceramics, modern ceramic material and nano technologies.
Glass:
Historical overview of glass making, Evans, Zacharias and Goldschmit theory, structure of glass, structural elements, nucleation and crystallisation, phase separation, viscosity and surface tension, optical and mechanical properties, types of glass, technology of glass

izdelave stekel, uporaba stekel, steklokeramika, biostekla, vlakna, glazure, emajli. Hidravlična veziva: zgodovinski pregled, surovine, reakcijski produkti, hidratacija, vezenje in strjevanje, tipi cementa, mineralna sestava, kemijske in fizikalne lastnosti, tehnologija izdelave, Portlandski cement, aluminatni cement, pucolanski in elektrofilterski cement.	making, applications, glass ceramics, fibres, glazes, enamels. Hydraulic binders: Historical overview, raw materials, reaction products, hydration, bonding and solidification, types of cement, mineral composition, chemical and physical properties, production technology, Portland cement, aluminate cement, pozzolan and fly-ash cement.

Temeljna literatura in viri / Readings:

1. Ceramic Materials, Science and Engineering, C.B. Carter, M.G.Norton, 2nd ed., Springer, 2013 (60%) 764 strani (60%)
2. Introduction to Glass Science and Technology, J.E.Shelby, The Royal Society of Chemistry, Cambridge, 2005 297 strani (20%)
3. Concrete – Microstructure, Properties, and Materials, P.Kumar Mehta, Paulo J.M.Monteiro,4th ed., McGraw-Hill Education, 2014, 675 strani (20%)

Cilji in kompetence:	**Objectives and Competences:**
Cilji: Predmet študente spoznava s področjem anorganskih nekovinskih materialov, ki je pomembno za številne slovenske industrijske organizacije. Vsebina predmeta uvaja študente v sestavo, strukturo, vrste in lastnosti ter tehnologije izdelave keramik in stekel. Seznanja ga z osnovnimi kemijskimi in fizikalnimi lastnostmi, principi izdelave in procesiranjem ter z načini uporabe anorganskih nekovinskih materialov. Predmet podaja tudi osnovna znanja o glazurah in emajlih ter hidravličnih vezivih. Specifične kompetence: Med izvajanjem predmeta se bo študent naučil logično povezovati sestavo in strukturo anorganskih nekovinskih materialov ter jih povezati z lastnostmi in možnostmi uporabe. Seznanil se bo tudi z vrstami in mehanizmi utrjevanja hidravličnih veziv s poudarkom na cementih. S tem bo pridobil znanja, ki jih lahko uporabi v proizvodnih in razvojnih enotah s področja materialov.	Introduction to inorganic non-metal materials, relevant to Slovenian industry. Students learn about the composition, structure, types, properties and technology of making ceramics and glass. This involves basic chemical and physical properties, technological principles and processing and applications of inorganic non-metal materials. The course provides bases on glazes and enamels and hydraulic binders. Subject-specific competences include: Making logical correlations between the composition and structure of inorganic non-metal materials and properties with possible applications; types and mechanisms of hardening of hydraulic binders with special emphasis on cements; making use of the knowledge acquired in processing and development units in the area of materials.

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

Znanje in razumevanje Predmet študentu daje znanje potrebno za razumevanje strukture in lastnosti keramike in stekel ter procesov njihove izdelave.	Knowledge and Comprehension Knowledge needed to correlate structure and processing parameters with properties of ceramics and glasses.
Uporaba Študent pridobi ustrezna osnovna znanja za razvojno in/ali tehnološko delo v različnih industrijskih ali raziskovalnih institucijah.	Application Students obtain necessary basic knowledge for integration in R&D and engineering groups in industrial and R&D institutions.
Refleksija Študent bo pridobil teoretična spoznanja s področja anorganskih nekovinskih materialov, ki jih bo lahko praktično uporabil v tehnologiji.	Analysis Students should be able to use theoretical knowledge in the field of ceramics, glasses and concrete for solving technological problems.
Prenosljive spretnosti Iskanje primerne literature in pisanje seminarskih nalog; kritična izbira informacij iz literature za opis in razlago specifičnega problema; predstavitev seminarjev ostalim študentom.	Skill-transference Ability Literature search; preparation and presentation of seminars; critical evaluation and selection of important data from literature for given specific problem.

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

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni in ustni izpit 80% Seminar 20%		

Reference nosilca / Lecturer's references:

1. **MARINŠEK, Marjan**, MEDEN, Anton, SKALAR, Tina, POČKAJ, Marta. The novel crystal structure with Zr[sub]6O[sub]4(OH)[sub]4 core and hydrazine carboxylate ligands, and its thermal properties. Acta chimica slovenica, 2014, vol. 61, no. 3, str. 439-446
2. **MARINŠEK, Marjan**. Ni-YSZ substrate degradation during carbon deposition. Boletin de la Sociedad Espanola de Ceramica y Vidrio, 2011, vol. 50, no. 3, str. 117-124
3. MAČEK, Jadran, NOVOSEL, Barbara, **MARINŠEK, Marjan**. Ni-YSZ SOFC anodes : minimization of carbon deposition. V: MAČEK, Marjeta (ur.), SUVOROV, Danilo. Refereed reports of IX Conference & Exhibition of the European Ceramic Society : 19-23 June 2005, Portorož, Slovenia, (Journal of the European ceramic society, vol. 27, no. 2-3, 2007). Amsterdam: Elsevier, 2007, vol. 27, no. 2/3, str. 487-491

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	KEMIJSKO INŽENIRSKA DINAMIKA
Course Title:	CHEMICAL ENGINEERING DYNAMICS

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

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: IN216

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. Igor Plazl / Dr. Igor Plazl, 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 modeliranja procesov; - sistematični pristop k modeliranju procesov; - zapis ohranitvenih enačb (snov, energija, gibalna količina); - kemijska kinetika, kemijsko in fazno ravnotežje; - osnove procesne dinamike; - meritev in odziv procesa; - odziv sistema prvega reda na stopenjsko in sinusno spremembo; - odzivi višjega reda; - osnove avtomatske regulacije (regulacija z negativno povratno vezjo, proporcionalno-integrirno-diferencirna (PID) regulacija, časovni odziv linearnih regulacijskih sistemov, načrtovanje in uglasitev regulatorja);	- modelling fundamentals; - systematic approach to modelling of processes; - balancing equations; - chemical kinetics, chemical and phase equilibrium; - process dynamics fundamentals; - measurement and process response; - first-order response to an input step-change and sinusoidal disturbance; - higher-order responses; - fundamentals of automatic control (feedback control loop , Proportional-Integral-Derivative (PID) control, response time of linear control systems, design and tuning of the regulator);

- vključitev konstitutivnih zvez regulacije v modelne enačbe za opis procesov; - simulacija, regulacija in optimizacija izbranih dinamičnih procesnih sistemov.	- integration of constitutive relationships of regulation into model equations for process description; - simulation, regulation and optimization of selected dynamic process systems.

Temeljna literatura in viri / Readings:

- J. Ingham, I. J. Dunn, E. Heinzle, J. E. Prenosil, J. B. Snape, Chemical engineering dynamics: An introduction to modelling and computer simulation, 3. Ed, Wiley-VCH Verlag GmbH and Co. KgaA, Weinheim, 2007, 618 pp., (30 %),
- D. E. Seborg, T. F. Edgar, D. A. Mellichamp, Process Dynamics and Control, 2. Ed, John Wiley & Sons, New York, 2004, 664 pp., (40 %)

Cilji in kompetence:	**Objectives and Competences:**
Cilj predmeta je, da študentje osvojijo znanja, potrebna za analizo in vodenje zahtevnejših realnih kemijskih procesov. Študentje pri predmetu pridobijo naslednje specifične kompetence: - poznavanje osnov modeliranja procesov; - poznavanje načinov regulacije procesov; - poznavanje konstitutivnih zvez regulacije in njihova vključitev v modelne enačbe realnih procesnih sistemov; - sposobnost simulacije, regulacije, optimizacije in avtomatizacije procesnih sistemov.	Acquiring knowledge for the analysis and management of complex real chemical processes. Subject specific competences include: - modelling fundamentals; - process regulations; - constitutive relationships of regulation and integration into model equations of real process systems; - simulation, regulation, optimisation and automation of process systems.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
<u>Znanje in razumevanje</u> Študent zna identificirati ključne dejavnike pri nadzoru kemijskih procesov, sposoben je pridobljena znanja uporabljati pri vzdrževanju in izboljševanju varnosti in ekonomičnosti obratovanja kemijskih obratov, sposoben je optimizirati obstoječe kemijske procese.	<u>Knowledge and Comprehension</u> Students will acquire a systematic approach to modeling of dynamic processes.
<u>Uporaba</u> Pridobljena znanja je sposoben uporabiti pri razvojnem in raziskovalnem delu na področjih razvoja in optimizacije procesov.	<u>Application</u> Possessing sufficient fundamental knowledge student can theoretically describe and optimize the process.
<u>Refleksija</u> Na osnovi osvojenih teoretičnih znanj študentje pridobijo veščine za analizo (bio)kemijskih procesov in prenos znanja v tehnološki proces.	<u>Analysis</u> Student is capable of using the knowledge of transport phenomena and kinetics to develop mathematical models and design the processes. This ability is also appreciated for

	communication and cooperation with other engineering professionals.
Prenosljive spretnosti Razvita sposobnost kritičnega razmišljanja in logičnega sklepanja. Sposobnost zbiranja in interpretacije podatkov.	Skill-transference Ability Identification and solving of problems. Experimental data collection, analysis and critical evaluation of results. The use of scientific literature, writing and presentation of reports.

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

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

Reference nosilca / Lecturer's references:

- LUBEJ, Martin, **PLAZL, Igor**. Theoretical and experimental study of iron catalyst preparation by chemical vapor deposition of ferrocene in air. The chemical engineering journal, ISSN 1385-8947. [Print ed.], 2014, vol. 242, no. 1, str. 306-312.
- SKUBIC, Blaž, LAKNER, Mitja, **PLAZL, Igor**. Sintering behaviour of expanded perlite thermal insulation board : modeling and experiments. Industrial & engineering chemistry research, ISSN 0888-5885. [Print ed.], 9. jul. 2013, vol. 52, no. 30, str. 10244-10249.
- SKUBIC, Blaž, LAKNER, Mitja, **PLAZL, Igor**. Microwave drying of expanded perlite insulation board. Ind. eng. chem. res.. [Print ed.], 2012, vol. 51, no. 8, str. 3314-3321.

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

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

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: IN221

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. Igor Plazl / Dr. Igor Plazl, 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):
- Splošni pojmi in definicije mikroreaktorske tehnologije (MRT), zgodovinski pregled razvoja MRT, MRT – nov koncept kemijskega inženirstva, definicija mikroreaktorja, prednosti in slabosti (bio)kemijskih procesov na mikro nivoju, področja uporabe mikronaprav, sodobne tehnike izdelave mikrosistemov; - mikrofluidna dinamika: paralelni tok mešljivih in nemešljivih tekočin v mikrokanalu, napoved 3D hitrostnega profila eno in dvofaznega sistema; - reakcijsko difuzijska dinamika v mikroreaktorju: razvoj 2D in 3D matematičnih modelov, ki vključujejo tok tekočin in	- General concepts and definitions of micro reactor technology (MRT), historical overview of MRT, MRT – a new concept in chemical engineering, definitions of micro reactor, advantages/disadvantages of (bio)chemical processes at a micro level, applications of micro equipment, modern techniques for manufacturing micro systems; - microfluid dynamics: parallel flow of miscible and immiscible liquids in a micro channel, predictions of 3D velocity profile in single and two-phase system; - reaction diffusion dynamics in micro reactors: development of 2D and 3D mathematical models which include the flow of liquids and reaction-diffusion elements;

reakcijsko-difuzijske člene; - napredna numerična orodja: implicitno reševanje kompleksnih nelinearnih sistemov, numerična analiza, ekvidistantne in neekvidistantne končne razlike, metoda končnih razlik na nepravilnih geometrijskih oblikah, uporaba računalniško matematičnih orodij (Mathematica, Mathlab, Comsol, CFD); - izbrani primeri: kontinuirna ekstrakcija s sočasno separacijo faz, encimsko katalizirana sinteza v mikroreaktorju, ionska tekočina in mikroreaktor; - nano in mikro mebranske tehnologije: transport skozi membrane in membranske operacije.	- advanced numeric tools: implicit solving of complex non-linear systems, numerical analysis, equidistant and nonequidistant finite differences, finite difference method on irregular geometrical shapes, use of computer mathematical tools (*Mathematica, Mathlab, Comsol, CFD*); - selected examples: continuous extraction with simultaneous phase separation, enzyme catalysed synthesis in a micro reactor, ionic liquid and microreactor; - nano and micro membrane technologies: transport through membranes and membrane operations.

Temeljna literatura in viri / Readings:

- O. Geschke, H. Klank, P. Tellemann, *Microsystem Engineering of Lab-on-a-Chip Devices*, Wiley-VCH, Weinham, 2004, 258 pp. (60%).
- V. Hessel, S. Hardt, H. Löwe, *Chemical Micro Process Engineering; Fundamentals, Modelling and Reactions*, Wiley-VCH, Weinham, 2004, 674 pp. (20%).

Dodatna literature/Additional literature:

- W. Ehrfeld, V. Hessel, H. Löwe, *Microreactors, New Technology for Modern Chemistry*, Wiley-VCH, Weinham, 2000, 282 pp.
- W. Menz, J. Mohr, O. Paul, *Microsystem Technology*, 2. Ed, Wiley-VCH, Weinham, 2001, 512 pp.
- V. Hessel, H. Löwe, A. Müller, G. Kolb, *Chemical Micro Process Engineering, Processing and Plants,* Wiley-VCH, Weinham, 2005, 657 pp.
- C.J.M. van Rijn, *Nano and Micro Engineered Membrane Technology*, 1. Ed, Elsevier B.V., Amsterdam, 2004, 398 pp.

Cilji in kompetence:	**Objectives and Competences:**
Cilj predmeta je, da študentje osvojijo osnove mikroprocesne tehnologije, ki predstavlja nov koncept v kemijsko inženirski znanosti, in nadgradijo svoja znanja iz področja fluidne dinamike, prenosa toplote in snovi, reakcijske kinetike in numeričnih orodij. Študentje si pri predmetu pridobijo naslednje specifične kompetence: - poznavanje mikroreaktorske tehnologije; - poznavanje nano in mikro membranske tehnologije; - poznavanje mikrofluidne dinamike; - poznavanje reakcijsko difuzijske dinamike v	Acquiring fundamentals of microprocess technology which is a new concept in chemical engineering science, upgrading knowledge in fluid dynamics, heat and mass transfer, reaction kinetics and numerical tools. Subject-specific competences include knowledge and skills for dealing with: - microreactor technologies; - nano and micro membrane technologies; - microfluid dynamics; - reaction diffusion dynamics in microsystems; - setting up model equations for describing (bio)chemical processes in a microreactor;

mikrosistemih; - sposobnost postavitve modelnih enačb za opis (bio)kemijskih procesov v mikroreaktorju; - poznavanje numeričnih metod za reševanje kompleksnih večdimenziskih nelinearnih sistemov na geometrijah nepravilnih oblik; - sposobnost numeričnih simulacij in analize realnih procesov v mikrosistemih; - sposobnost optimizacije procesov in načrtovanja mikronaprav; - sposobnost uvajanja mikroprocesnih tehnoloških rešitev realnih problemov.	- numerical methods for solving complex multidimensional non-linear systems in irregular shape geometries; - numerical simulations and analyses of real processes in microsystems; - Process optimisation and designing micro equipment; implementing microprocess technological solutions to real problems.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
Znanje in razumevanje Študentje pridobijo splošna znanja o mikroreaktorski tehnologiji in dodatna znanja iz mikrofluidne in reakcijsko difuzijske dinamike v mikroreaktorju. Poleg tega nadgradijo svoja znanja iz numeričnih orodij, ki so potrebna pri kemijsko inženirski analizi (bio)kemijskih procesov v mikronapravah. Študentje pridobijo tudi temeljna znanja iz nano in mikro membranskih tehnologij.	Knowledge and Comprehension Students will acquire a systematic approach to modeling of dynamic processes.
Uporaba Uporaba načel mikrofluidne dinamike in reakcijsko difuzijskih pojavov v mikrosistemih študentom omogoča matematično fizikalni opis problemov. Aplikacija zahtevnejših numeričnih metod v matematično programskih orodjih jim omogoča reševanje in analizo nastavljenih realnih problemov. Študentje tako pridobijo uporabna znanja za opis (bio)kemijskih procesov in načrtovanje mikronaprav pri razvoju novih produktov.	Application Possessing sufficient fundamental knowledge student can theoretically describe the convection-diffusion dynamics with reaction at the micro scale and design the microreactor.
Refleksija Študentje so sposobni samostojno sklepati, definirati problem, postavljati zaključke in probleme reševati.	Analysis Student is capable of using the knowledge of transport phenomena and kinetics at the micro scale to design the micro flow devices for process intensification.
Prenosljive spretnosti Študentje znajo identificirati in reševati probleme, sposobni so zbiranja in interpretacije podatkov, kritične analize in sinteze pridobljenih znanj.	Skill-transference Ability Identification and solving of problems. Experimental data collection, analysis and critical evaluation of results. The use of scientific literature, writing and presentation of reports.

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

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

Reference nosilca / Lecturer's references:

- UNGERBÖCK, B., POHAR, Andrej, MAYR, T., **PLAZL, Igor**. Online oxygen measurements inside a microreactor with modeling of transport phenomena. *Microfluid. nanofluid*. (Print), 2013, vol. 14, no. 3/4, str. 565-574.
- POHAR, Andrej, ŽNIDARŠIČ PLAZL, Polona, **PLAZL, Igor**. Integrated system of a microbioreactor and a miniaturized continuous separator for enzyme catalyzed reactions. *Chem. eng. j.* 1996. [Print ed.], 2012, vol. 189/190, no. 1, str. 376-382.
- POHAR, Andrej, **PLAZL, Igor**, ŽNIDARŠIČ PLAZL, Polona. Lipase-catalyzed synthesis of isoamyl acetate in an ionic liquid/n-heptane two-phase system at the microreactor scale. *Lab chip* (Print), 2009, vol. 9, no. 23, str. 3385-3390.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	MAGISTRSKO DELO
Course Title:	MASTER'S THESIS

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
MAG Kemijsko inženirstvo, 2. stopnja	**/**	**2.**	**3. in 4.**
USP Chemical Engineering, 2nd Cycle	**/**	**2nd**	**3rd and 4th**

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: IN223

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Work	Druge oblike študija	Samost. delo Individual Work	ECTS
/	/	/	/	450	/	30

Nosilec predmeta / Lecturer: /

Jeziki / Languages:

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Študent oz. kandidat mora imeti predmet opredeljen kot študijsko obveznost.

Prerequisites:

The course has to be assigned to the student.

Vsebina:

Magistrsko delo se opravlja iz področja kemijskega inženirstva. Vsebina in naslov se določata v soglasju z izbranim mentorjem – nosilcem ene izmed vsebin v programu.

Content (Syllabus outline):

Master's thesis is performed in one of the areas of chemical engineering. Contents and Master's thesis title are agreed upon with the mentor.

Temeljna literatura in viri / Readings:

- knjige in članki, ki so povezani z vsebino magistrskega dela/ Books and journal articles related to the research topic.

Cilji in kompetence:

Dokončno oblikovanje pričakovanega lika magistranta. Študent bodo ob izdelavi magistrske naloge pokazal sposobnosti iskanja in zaznavanja problemov kemijskega inženirstva in znal poiskati rešitev za tak

Objectives and Competences:

Final formation of the competences of a master's degree candidate; Through carrying out research for the master's thesis students should be able to demonstrate the skills for autonomous identification of a problem and

problem. Pri delu bodo pokazal, da je pridobil večino kompetenc navedenih v programu študija.	finding solutions, thus proving that specific competences from other courses have been acquired.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
Znanje in razumevanje Pri izdelavi magistrskega dela bo slušatelj pridobil: - sposobnosti formuliranja problema, - sposobnosti samostojnega iskanja ustrezne literature, - sposobnosti obravnavanja problema v praksi, - sposobnosti iskanja kvantitativnih rešitev in utemeljevanja ustreznosti rešitev, - sposobnosti predstavitve rezultatov svojega dela.	Knowledge and Comprehension Ability to formulate the problem and research literature independently; Ability of independent problem managing in practice; Ability of independent quantitative problem solving and argumentation of the solution; Ability of presenting results of research work.
Uporaba Znanje in pridobljene veščine bo magistrant lahko uporabil pri opravljanju poklica.	Application Acquired is necessary for professional work.
Refleksija Povezovanje vseh pridobljenih teoretičnih znanj z reševanjem problemov na področju kemijskega inženirstva ter kritični pogled na uporabnost teh znanj.	Analysis Integration of knowledge from different topics from chemical engineering and supporting sciences; Development of a critical view on the knowledge applicability.
Prenosljive spretnosti Pri delu bo magistrant pridobil znanja o metodah reševanja kompleksnih problemov, o načinu prezentacije teh znanj v pisani in govorjeni obliki povezani z ostalimi metodami posredovanja raziskav, ugotovitev itd.	Skill-transference Ability Ability of solving complex problems using different methods; Ability of presenting research results in a written and oral form.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Individualno delo mentorja in samostojno študijsko in raziskovalno delo.	Independent research work supervised by the mentor.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Ocenjuje se magistrsko delo (50 %) in zagovor magistrskega dela (50 %) Komisijo sestavljajo predsednik, mentor in član. Lestvica ocen vsakega dela je od 1 do 10. Ocene 1 do 5 so negativne, ocene 6 do 10 pa pozitivne in sicer: 6-zadostno, 7-		Master's thesis and its presentation are graded separately by a three-member commission (chairman, mentor, additional member) against the grading scale from 1- 10 (grades from 6 – 10 are positive and 1 -5 negative (6-pass, 7-fair, 8 and 9-very good, 10-excellent).

-dobro, 8 in 9-prav dobro, 10-odlično.		

Reference nosilca / Lecturer's references:

/

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	MANAGEMENT IN EKONOMIKA PROJEKTOV
Course Title:	MANAGEMENT AND PROCESS ECONOMICS

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

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: IN222

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

Nosilec predmeta / Lecturer: prof. dr. Mojca Marc / Dr. Mojca Marc, Full Professor
doc. dr. Darija Aleksić / Dr. Darija Aleksić, 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):**
Študenti bodo v okviru predmeta spoznali: - management projektov kot vodilo uspešne izvedbe delovnih procesov - projektni management in njegove posebnosti - pomen planiranja ter analiziranja v projektnem managementu - vodenje tima in posameznikov - projektno in razvojno delovanje skupin - zasnova ter organiziranje projektnih skupin - kadrovska sestava projektnih timov - delo v projektnih timih - vloga managerja projekta - kako sestaviti poslovni načrt in elaborat/plan projekta - kako projektno nalogo predstaviti ter	Students in this course will learn: - project management as a guide of the successful execution of business processes - project management and its characteristics - the importance of planning and analysis in project management - how to lead team and individuals - project and development operation of groups - conception and organization of project teams - staffing of the project teams - work in project teams - the role of the project manager - how to prepare the project business case and the project plan - how to present a project task, how to verified

verificirati, jo razstaviti v posamezne faze ter za njihovo realizacijo izbrati ustrezne izvajalce - sistemi projektnih ključev - delitev nalog in nagrajevanje pri projektnem načinu dela - finančna shema managementa projektov - doseganje končnega cilja projekta, vizija, nevarnosti - projektno načrtovanje, vsebina in način izdelave poslovnega načrta kazalniki za vrednotenje uspešnosti projektov	it, structured it into phases, and select appropriate providers for tasks realization - a systems of project keys - the division of tasks and rewarding work in project - a financial scheme of project management - the achieving of the final project objective, the vision, and the risks - project planning, content and the way of a business plan preparation Indicators for evaluating the success of projects

Temeljna literatura in viri / Readings:

Temeljna literatura:

- Drnovšek, M. in Stritar, R.: Priročnik za pisanje poslovnega načrta. Ekonomska fakulteta, Ljubljana, 2007, 137 str. (100%)
- Stare, A.: Projektni management: teorija in praksa. Agencija Poti, Ljubljana, 2011, 340 str. (90%)

Dopolnilna literatura:

- Brigham E.F., Gapenski, L. C.: Financial management: Theory and Practice. The Dryden Press, New York, 1991, 995 str. (poglavje 9)
- Kerzner, H. Project management: a systems approach to planning, scheduling, and controlling. John Wiley & Sons, New York, 2009, 1094 str.
- Kosi, U., Marc, M. in Peljhan, D.: Uvod v poslovanje. Ekonomska fakulteta, Ljubljana, 2007, 95 str.
- Levy H., Sarnat M.: Capital Investment and Financial Decisions. Prentice Hall International, New York, 1994, 782 str. (poglavja od 1 do 6)
- PMBOK - A guide to the project management body of knowledge. Project management institute, Newtown Square, 2008, 467 str.

Wysocki, R.K. Effective project management: traditional, agile, extreme. Wiley Publishing, Indianapolis, 2009, 734 str.

Cilji in kompetence:	**Objectives and Competences:**
Cilj predmeta je študentom razvijati zavest o pomenu projektnega managementa v gospodarskih družbah, razvijati zmožnosti za timsko delo v podjetjih, razvijati sposobnosti za presojo poslovnih priložnosti, naučiti obvladovati metode in tehnike projektnega managementa ter pridobiti zmožnosti za samostojno vodenje. Študentje si pri predmetu pridobijo naslednje specifične kompetence: - vključevanje v poslovni proces - sistematičnost pristopa k načrtovanju	The objective of the course is to develop an awareness of the importance of project management in companies, to develop the capacity for teamwork in companies, to develop capacity to assess business opportunities, to learn to use the project management methods and techniques, and obtain the capacity for independently management. Students will gain the following specific competences: - the integration into the business process - a systematic approach to business planning in

poslovanja v podjetju - uporaba orodij za presojo uspešnosti projektnega managementa - sistematični pristop k ustvarjanju, pridobivanju in prenosu znanja v prakso - usposobljenost za samostojno izdelavo projektov, njihovo vrednotenje, presojo uspešnosti uvajanja v prakso usposobljenost za management projektov	the company - the usage of tools to assess the effectiveness of project management - a systematic approach for the creation, acquisition and transfer of the knowledge into the practice - the ability to independently create projects, evaluate them, and assess of the successful introduction into practice ability to manage projects

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
Znanje in razumevanje Študentje bodo spoznali in razumeli: - pojme s področja ekonomija, podjetništvo, projektni management in organiziranje dela, v projektnih skupinah, vodenje projektnih timov, - osnovne zakonitosti projektnega managementa ter organizacije dela v gospodarskih družbah, s poudarkom na primerih iz prakse kakor tudi iz študentovih življenjskih potreb ter izkušenj	Knowledge and Comprehension Students will learn and understand: - terms from economics, entrepreneurship, project management and work organization, project teams, basic principles of project management and work organization in companies with emphasis on case studies and the student needs and experiences
Uporaba Predmet je usmerjen v razumevanje in prepoznavanje značilnosti projektnih podvigov v različnih fazah rasti, analizi podatkov in informacij za management projektov, izdelavi poslovnega načrta za presojo izbrane poslovne ideje, v načrtovanje organizacije enostavnejših in manj zahtevnih projektov, določitev matrike odgovornosti, načrtovanju časa, virov sredstev, dela , stroškov, ozkih grl, analizi in učinkovitosti projektov.	Application The course is focused on understanding and identifying the characteristics of projects in various stages of growth, data analysis and information for project management, preparing the business plan for the assessment of selected business ideas, in the organization planning of simpler and less complex projects, the determination of the responsibility matrix, the planning of time, resources, work, costs, bottlenecks, the analyses and the efficiency of projects.
Refleksija Študentje bodo interpretirali ter pred kolegi analizirali lastno razumevanje projektnega dela, izbranih zahtevni ter manj zahtevnih projektov s področja kemijske stroke. Pri tem bodo uporabili pridobljena teoretična znanja ter jih vrednotili s predstavljenimi praktičnimi problemi oziroma izkušnjami.	Analysis Students will interpret colleagues their own understanding of project work, selected demanding and less demanding projects in the field of chemistry. In this they will use the acquired knowledge and will evaluate them with the presented practical problems or experiences.
Prenosljive spretnosti Pri predmetu bo študent pridobil sposobnosti razumevanja projektnega dela, dela v	Skill-transference Ability Student will acquire skills for understanding of project work, work in teams, the importance of

skupinah, pomena projektnega managementa za uspešen management poslovnega procesa v gospodarskih družbah ter v zavodih, za razumevanje strokovne literature. Pridobljene spretnosti bodo študentje znali uporabljati pri organizaciji timskega dela .	project management for the successful management of the business process in companies and institutions, for understanding the scientific literature. Students will be able to use the acquired skills for the organization of teamwork.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Predavanja s pomočjo različnih AV sredstev. Študentom podamo uvod v obravnavano snov, jih napotimo na obravnavo uspešno rešenih projektov v praksi, tudi s pomočjo strokovnjakov iz prakse. Izdelava poslovnega načrta za primer iz kemijske stroke, skupinska obravnava dobljenih rezultatov.	Lectures with AV. We give students an introduction of the topic, assign them to deal the successfully solved projects from practice, also with the help of practitioners. Creating a business plan for the chemistry case, group discussion of the obtained results.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni izpit	70%	Written exam
Projektna naloga	30%	Project work

Reference nosilca / Lecturer's references:

JAVORNIK, Samo, TEKAVČIČ, Metka, **MARC, Mojca**. The efficiency of intellectual capital investments as a potential leading indicator. International business & economics research journal.

TEKAVČIČ, Metka, ŠOBOTA, Aleksandra, PELJHAN, Darja, **MARC, Mojca**, PONIKVAR, Nina. Spremljanje uspešnosti poslovanja v velikih slovenskih podjetjih. IB revija.

MARC, Mojca, PELJHAN, Darja, PONIKVAR, Nina, ŠOBOTA, Aleksandra, TEKAVČIČ, Metka. Performance measurement in large Slovenian companies: an assessment of progress. International journal of management & information systems.

ALEKSIĆ, Darija, MIHELIČ, Katarina Katja, ČERNE, Matej, ŠKERLAVAJ, Miha. Interactive effects of perceived time pressure, work-family balance satisfaction (SWFB), and leader-member exchange (LMX) on creativity. Personnel review, ISSN 0048-3486, 2017, vol.46, iss. 3, str. 667-679.

ALEKSIĆ, Darija, ČERNE, Matej, DYSVIK, Anders, ŠKERLAVAJ, Miha. I want to be creative, but ... : preference for creativity, perceived clear outcome goals, work enjoyment, and creative performance. European journal of work and organizational psychology, ISSN 1359-432X, 2016, vol. 25, iss. 3, str. 363-383.

ALEKSIĆ, Darija, ŠKERLAVAJ, Miha, DYSVIK, Anders. The flow of creativity for idea implementation. V: ŠKERLAVAJ, Miha (ur.), et al. Capitalizing on creativity at work : fostering the implementation of creative ideas in organizations. Cheltenham; Northampton: Edward Elgar. 2016, str. 29-38.

ALEKSIĆ, Darija, BOGILOVIĆ, Sabina, ČERNE, Matej. Mikro temelji inovativnosti : položaj Slovenije v primerjavi s sedmimi državami v Jadranski regiji = Micro-foundations of innovation : the position of Slovenia compared with seven countries in the Adriatic region. V: DOUCEK, Petr (ur.),

NOVAK, Aleš (ur.), PAAPE, Björn (ur.). Internacionalizacija in sodelovanje : zbornik 34. mednarodne konference o razvoju organizacijskih znanosti = Internationalization and cooperation : proceedings of the 34th International Conference on Organizational Science Development, 34. Mednarodna konferenca o razvoju organizacijskih znanosti, Portorož, 25.-27. marec 2015. Kranj: Moderna organizacija, 2015, str. 13-24.

ALEKSIĆ, Darija, ČERNE, Matej, ŠKERLAVAJ, Miha. Hi-tech innovation through circuits of knowledge. V: SITAR, Aleša Saša (ur.), et al. Knowledge management and organizational learning : conference papers, 3rd International Conference on Management and Organisation, Brdo pri Kranju, 12-13 June 2014. Ljubljana: The Slovenian Academy of Management, 2014, str. 170-187.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	NAČRTOVANJE KEMIJSKIH PROCESOV
Course Title:	CHEMICAL PROCESS DESIGN

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

Vrsta predmeta / Course Type: izbirni strokovni / Elective Professional

Univerzitetna koda predmeta / University Course Code: IN2I07

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

Nosilec predmeta / Lecturer: prof. dr. Igor Plazl / Dr. Igor Plazl, 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):
Temeljna vsebinska področja predmeta so: - sinteza procesa: strategija in konceptualno načrtovanje, dekompozicijske in hevristične strategije; - pinch analiza: termodinamika, mreža toplotnih izmenjevalcev; - preliminarna analiza procesa: poenostavljene snovne in energijske bilance, prostostne stopnje, »short cut« metode, algoritmi za reševanje procesnih shem; - integracija procesa: toplotni stroji, toplotne črpalke, separatorji, reaktorji; - načrtovanje procesov z uporabo pinch tehnologije, nizanje separatorjev, sinteza toplotnih izmenjevalcev; - modeli in algoritmi za osnovne operacije;	Basic content of the course: - process synthesis: strategy and conceptual design, decomposable and heuristic strategies, - pinch analysis: thermodynamics, network of heat exchangers, - preliminary process analysis: simplified mass and heat balances, degree of freedom, short cut methods, algorithms for solving process schemes, - process integration: heat engines, heat pumps, separators, reactors, - process design by pinch technologies, series of separators, synthesis of heat exchangers, - models and algorithms for unit operations, - economic process evaluation: equipment and costs,

- ekonomska evalvacija procesa: oprema in stroški, preračuni finančnih tokov; - simulacijski koncepti načrtovanja procesov: modularni in sekvenčni pristop, analiza procesnih shem; - numerične metode za velike sisteme nelinearnih algebraičnih enačb.	- simulation concept of process design, analysis of process schemes, - numerical methods for solving large systems of nonlinear equations.

Temeljna literatura in viri / Readings:

- W. D. Seider, J. D. Seader, D. R. Lewin, Process Design Principles: Synthesis, Analysis and Evaluation, John Wiley & Sons, Inc., New York, 1998, 824 str., (40 %).
- L. T. Biegler, I. E. Grossmann, A. W. Westerberg et al., Systematic Methods of Chemical Process Design, Prentice Hall, 1997, 700 str., (20 %).

Cilji in kompetence:	**Objectives and Competences:**
Cilj predmeta je, da študentu ponudi znanja, ki so potrebna za integralno načrtovanje kemijskih procesov. Študentje pri predmetu pridobijo naslednje specifične kompetence: - sposobnost analize in sinteze procesov; - integracija procesnih aparatov v procesne sheme; - sposobnost načrtovanja enostavnejših kemijskih procesov.	Course provides knowledge that is needed in its integral approach to the chemical process design. Student gains the following specific competences: ability to analyze and synthesize processes, integrate individual apparatuses into a process scheme, ability to design a simple chemical process.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
Znanje in razumevanje Študent zna identificirati ključne dejavnike pri sintezi in analizi kemijskih procesov, sposoben je pridobljena znanja uporabljati pri načrtovanju kemijskih obratov s stališča procesne opreme in ekonomike procesa.	Knowledge and Comprehension Student is able to identify and understand key issues in the synthesis and analysis of chemical processes and use a newly gained knowledge in the design of chemical plants from the point of process equipment and process economics.
Uporaba Pridobljena znanja je sposoben uporabiti pri načrtovanju novih in analizi obstoječih procesov.	Application Possessing sufficient knowledge student can design new and analyze existing processes.
Refleksija Na osnovi osvojenih teoretičnih znanj študentje pridobijo veščine za analizo (bio)kemijskih procesov in prenos znanja v tehnološki proces.	Analysis Theoretical knowledge gained during the course can be efficiently transferred into new technological routes of chemical processes.
Prenosljive spretnosti Razvita sposobnost integracije temeljnih kemijsko inženirskih znanj.	Skill-transference Ability Well-developed skills of integrating fundamental chemical engineering knowledge into industrial processes.

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

Predavanja, seminarji	Lectures, seminars.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni in ustni izpit. 80% Predstavitev seminarja. 20%		

Reference nosilca / Lecturer's references:

- R.Wohlgemuth, **I. Plazl**, P. Žnidaršič Plazl, K. V. Gernaey, J. M. Woodley. Microscale technology and biocatalytic processes: opportunities and challenges for synthesis. Trends Biotechnol., May 2015, vol. 33, iss. 5, str. 302-314.
- G.N. Jovanovic, J. E. Atwater, P. Žnidaršič Plazl, **I. Plazl**. Dechlorination of Polychlorinated Phenols on Bimetallic Pd/Fe Catalyst in a Magnetically Stabilized Fluidized Bed. Chem. Eng.J., 2015, 274:50-60.
- SKUBIC, Blaž, LAKNER, Mitja, **PLAZL, Igor**. Microwave drying of expanded perlite insulation board. Industrial & engineering chemistry research, ISSN 0888-5885. [Print ed.], 2012, vol. 51, no. 8, str. 3314-3321.
- SKUBIC, Blaž, LAKNER, Mitja, **PLAZL, Igor**. Sintering behavior of expanded perlite thermal insulation board : modeling and experiments. Industrial & engineering chemistry research, ISSN 0888-5885. [Print ed.], 9. jul. 2013, vol. 52, no. 30, str. 10244-10249.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	NANOMATERIALI IN KOMPOZITI
Course Title:	NANOMATERIALS AND COMPOSITES

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

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: IN212

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

Nosilec predmeta / Lecturer: izr. prof. dr. Marjan Marinšek / Dr. Marjan Marinšek, Associate Professor
prof. dr. Urška Šebenik / Dr. Urška Šebenik, 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):
- Definicija nanotehnologije, nanomateriala, nanostrukturiranega materiala, kompozita, nanokompozita; - Osnovne značilnosti nanomaterialov in nano efekt: površinski in kvantni prispevek, - Strukturne značilnosti nanodelcev, samoorganiziranje gradnikov v klastre, nanodelce, enoslojne in večslojne cevke, paličice in žičke, tanke filme; - Sinteza nanomaterialov; - Sinteza/priprava nanokompozitov in nanostrukturiranih materialov; - Odvisnost lastnosti nanostrukturiranih materialov in nanokompozitov od njihove	- Definition of nanotechnologies, nanomaterials, nanostructured materials, composites, nanocomposites; - Basic characteristics of nanomaterials: surface and quantum effects; - Structural characteristics of nanoparticles, self assembly of clusters, nanoparticles, single and multiple-walled nanotubes, nanorods and nanowires, thin films; - Synthesis of nanomaterials; - Synthesis/preparation of nanocomposites and nanostructured materials; - Dependence of nanomaterials and nanocomposites properties on their structure

strukture in drugih karakteristik; - Polimerni nanokompoziti (polimerne zmesi, polimer/nanopolnilo) in primerjava s klasičnimi polimernimi kompoziti; - Sodobne karakterizacijske tehnike za nanostrukturirana materiale in nanokompozite; - Uporaba nanostrukturiranih materialov in nanokompozitov.	and other characteristics; - Polymer nanocomposites (polymer blends and polymer/nanofiller composites) and comparison wit classical polymer composites; - Modern characterization techniques for nanomaterials and nanocomposites; - Uses of nanostructured materials and nanocomposites.

Temeljna literatura in viri / Readings:

- M. Kuno, Introductory nanoscience, Garland Science, Taylor & Francis Group, LCC, New York, 2012, 447 str. (40 %)
- M. Hosokawa, K. Nogi, M. Naito, T. Yokoyama, Nanoparticle technology handbook, Elsevier, Amsterdam, 2012, 703 str. (20 %)
- K. Friedrich, S. Fakirov, Z. Zhang, Polymer composites : from nano-to-macro-scale. Springer, New York, 2005, 341 str. (50 %).

Dopolnilna literatura:

- D. R. Paul, L. M. Robeson, Polymer nanotechnology: Nanocomposites. Polymer, 2008, 49(15), 3187-3204 str.
- J. H. Koo, Polymer nanocomposites: processing, characterization, and applications. MCGraw-Hill Professional, New York, 2006, 261 str.

Cilji in kompetence:	**Objectives and Competences:**
Cilj predmeta je, da študentje osvojijo osnovna znanja o novih, naprednih materialih, ki v zadnjem desetletju predstavljajo revolucijo in perspektivo na področju znanosti o materialih. Študentje pri predmetu pridobijo naslednje specifične kompetence: - poznavanje definicije nanomaterialov, nanokompozitov in nanostrukturiranih materialov; - poznavanje osnovnih vrst nanostrukturiranih materialov, - poznavanje metod in procesov za priparvo vseh vrst nano materialov, - poznavanje karakterizacije nano materialov, - poznavanje možnosti tehnoloških aplikacij vseh vrst nano materialov.	Acquiring the knowledge and ability for further studies and research of nanomaterials, relating the basic differences of these materials to bulk materials to the size and quantum effects, knowing basic methods and processes for their preparation and characterization, foreseeing possible use of such materials. Acquiring fundamental knowledge about nanomaterials and nanocomposites which represent a revolution and open new perspectives in the field of material science.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
Znanje in razumevanje Študent bo znanja s področja klasičnih materialov razširil na nanopodročje, tj.	Knowledge and Comprehension Extension of knowledge in the area of materials with knowledge specific to nanomaterials,

nanomateriale, nanokompozite, nanostrukturirane materiale. Razumel bo izvor nano-efekta pri nanomaterialih.	nanocomposites and nanostructured materials. Understanding the nanoeffect.
Uporaba Specifične lastnosti nanomaterialov, nanokompozitov in nanostrukturiranih materialov bo analiziral gleda na potencialne možnosti za njihovo uporabo in pri pri načrtovanju novih materialov.	Application Designing novel, advanced nanomaterials, nanocomposites and nanostructured materials for specific applications.
Refleksija Študent bo specifična znanja o nanomaterialih koreliral s klasičnimi materiali, tako glede njihovih osnovnih lastnosti kot tudi metod oziroma procesov za njihovo pripravo ter uporabo.	Analysis Correlation and comparison of specific properties of nanomaterials and nanocomposites with properties, preparation methods and applications of classic materials and composites.
Prenosljive spretnosti Iskanje domače in tuje literature iz različnih virov, zbiranje, obdelava in interpretacija podatkov, analiza in sinteza rezultatov, pisanje člankov ipd.	Skill-transference Ability Literature research; Literature data collecting, analysis and interpretation; Results analysis and interpretation; Project work presentation.

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

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni in ustni izpit. Opravljena seminarska naloga je pogoj za pristop k izpitu.		Written and oral exam. Accomplished project work is a prerequisite to exam attendance.

Reference nosilca / Lecturer's references:

- **MARINŠEK, Marjan**, ŠALA, Martin, JANČAR, Boštjan. A study towards superior carbon nanotubes-supported Pd-based catalysts for formic acid electro-oxidation : preparation, properties and characterisation. *Journal of power sources*, ISSN 0378-7753, 2013, vol. 235, no. 1, str. 111-116
- **MARINŠEK, Marjan**, ZUPAN, Klementina. Microstructure evaluation of sintered combustion-derived fine powder NiO-YSZ. *Ceramics international*, ISSN 0272-8842. [Print ed.], 2010, vol. 36, no. 3, str. 1075-1082
- JAPIĆ, Dajana, PARAMO, Jorge Antonio, **MARINŠEK, Marjan**, STRZHEMECHNY, Yuri M., CRNJAK OREL, Zorica. Growth-morphology-luminescence correlation in ZnO-containing nanostructures synthesized in different media. *Journal of luminescence*, ISSN 0022-2313. [Print ed.], 2012, vol. 132, iss. 6, str. 1589-1596
- KRAJNC, Matjaž, KARGER-KOCSIS, József, **ŠEBENIK, Urška**. Grafting of maleic anhydride onto an ethylene-propylene-diene terpolymer and concurrent organoclay nanocomposite

preparation in solution and melt. *Journal of applied polymer science*, ISSN 0021-8995, 2013, vol. 127, no. 2, str. 950-958. [COBISS.SI-ID 35973125]

- KAJTNA, Jernej, **ŠEBENIK, Urška**. Microsphere pressure sensitive adhesives - acrylic polymer/montmorillonite clay nanocomposite materials. *International journal of adhesion and adhesives*, ISSN 0143-7496. [Print ed.], 2009, vol. 29, no. 5, str. 543-550. [COBISS.SI-ID 30208773]
- **ŠEBENIK, Urška**, KRAJNC, Matjaž. Acrylic-clay nanocomposites by suspension and emulsion polymerization. V: MITTAL, Vikas (ur.). *Polymer nanocomposites by emulsion and suspension polymerization*, (RSC nanoscience & nanotechnology, ISSN 1757-7136, no. 16). Cambridge: RSC Pub., cop. 2011, str. 111-123. [COBISS.SI-ID 34554629]

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	ORGANSKI PREMAZI
Course Title:	ORGANIC COATINGS

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

Vrsta predmeta / Course Type: izbirni strokovni / Elective Professional

Univerzitetna koda predmeta / University Course Code: IN2I10

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: prof. dr. Matjaž Krajnc / Dr. Matjaž Krajnc, 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):
Temeljna vsebinska področja predmeta so: - formiranje premaznih filmov; - tokovne lastnosti organskih premazov; - mehanske lastnosti organskih premazov; - stabilnost in odpornost organskih premazov na vplive okolja; - adhezija; - korozijska zaščita premazov, - lateksi, - pregled veziv in njihove lastnosti, - topila, - barva in pigmenti; - pigmentne disperzije; - načini aplikacije organskih premazov, - defekti premaznega filma; - formulacije in priprava organskih premazov	Formation of organic coatings, flow characteristics, mechanical properties, stability and resistance to environmental effects, adhesion, corrosion protection, latexes, solvents, colour and pigments, pigment dispersions, ways of applications of organic coatings, organic coating defects, formulations and preparations, scale-up and transfer of technology to the production.

(izbrani primeri); - povečevalni kriteriji in prenos tehnologije v proizvodnjo.	

Temeljna literatura in viri / Readings:

- Z. W. Wicks, F. N. Jones, S. P. Pappas, Organic Coatings: Science and Technology, 2. izdaja, John Wiley &b Sons, Inc., New York, 1999, 595 str., (60 %).

Dopolnilna literatura:
- T. C. Patton, Paint Flow and Pigment Dispersion: A Rheological Approach to Coating and Ink Technology, 2. izdaja, John Wiley &b Sons, Inc., New York, 1979, 615 str.

Cilji in kompetence:	**Objectives and Competences:**
Cilj predmeta je, da študentje osvojijo različne stopnje razvoja organskih premazov. Študentje pri predmetu pridobijo naslednje specifične kompetence: - poznavanje nastanka oz. formiranja premaznega filma; - poznavanje tokovnih lastnosti različnih premazov; - poznavanje ključnih lastnosti premazov in premaznih filmov z vidika njihove uporabe; - poznavanje premaznih komponent in njihove vloge; - poznavanje načina aplikacije premazov; - razumevanje izbranih primerov formulacij in priprave organskih premazov: - razumevanje povečevalnih kriterijev in prenos tehnologije v proizvodnjo.	Understanding the formation of coatings. Understanding flow characteristics of various coatings. Knowing key characteristics of coatings from the application perspective. Knowing coating components and their roles. Knowing the application of coatings. Understanding selected cases of formulation and preparation of organic coatings. Understanding the scale-up criteria and transfer of a technology to production.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
<u>Znanje in razumevanje</u> Študent osvoji znanja o lastnostih organskih premazov in njihovih filmov. Razume nastanek premaznega filma. Razume vpliv sestave premaza na lastnosti premaza in premaznega filma. Pozna osnovno formulacijo premaza. Pozna povečevalne kriterije za prenos tehnologije v proizvodni proces.	<u>Knowledge and Comprehension</u> Understanding different levels in the development of organic coatings.
<u>Uporaba</u> Pridobljena znanja je študent sposoben uporabiti pri svojem raziskovalnem delu na področju razvoja in optimizacije organskih premazov.	<u>Application</u> Student is able to apply the knowledge at independent research and development work in the area of organic coatings development and optimization.

Refleksija Študent je sposoben sintetizirati znanja s področij polimerne kemije, polimernih materialov ter produktnega inženirstva.	Analysis Student is able of synthesis of polymer chemistry, polymer materials and product engineering scientific fields.
Prenosljive spretnosti Študent je sposoben uporabljati tujo in domačo strokovno literaturo. Sposoben je samostojno sklepati, definirati problem, postavljati zaključke in problem reševati. Sposoben je zbirati in obdelovati podatke, predstaviti rezultate v pisni in ustni obliki.	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, vaje	Lectures, seminars, laboratory practice

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni in ustni izpit. 70% Seminarska naloga. 30% Opravljene laboratorijske vaje in seminarska naloga so pogoj za pristop k izpitu.		Written and oral exam Project work.

Reference nosilca / Lecturer's references:

- ŠEBENIK, Urška, **KRAJNC, Matjaž**. Semibatch emulsion polymerization of methyl methacrylate using different polyurethane particles. *Journal of polymer science. Part A, Polymer chemistry*, ISSN 0887-624X, 2005, vol. 43, no. 4, str. 844-858, graf. prikazi. [COBISS.SI-ID 26393349]
- 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, **KRAJNC, Matjaž**. Seeded semibatch emulsion copolymerization of methyl methacrylate and butyl acrylate using polyurethane dispersion : effect of soft segment length on kinetics. *Colloids and surfaces. A, Physicochemical and Engineering Aspects*, ISSN 0927-7757. [Print ed.], 2004, vol. 233, no. 1/3, str. 51-62, graf. prikazi. [COBISS.SI-ID 25609989]

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	POLIMERNO PROCESNO INŽENIRSTVO
Course Title:	POLYMER PROCESS ENGINEERING

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

Vrsta predmeta / Course Type: izbirni strokovni / Elective Professional

Univerzitetna koda predmeta / University Course Code: IN2I09

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: prof. dr. Matjaž Krajnc / Dr. Matjaž Krajnc, 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):
Temeljna vsebinska področja predmeta so: - teorija in praktična uporaba enačb za ohranitev mase, gibalne količine in energije; - reološko, termodinamsko in tribološko obnašanje polimernih materialov; - taljenje, črpanje in mešanje polimernih materialov; - kompaundiranje; - kompresijsko brizganje, injekcijsko brizganje, ekspanzijsko brizganje; - kalandriranje; - ekstrudiranje: tok taline, zadrževalni čas, deformacije, dimenzioniranje ekstruderja, povečevanje ekstruzijskega procesa na osnovi modelne teorije.	Theoretical and practical use of conservation equations (mass, heat and momentum). Rheological, thermodynamic and tribological behaviour of polymer materials. Polymer melting, pumping and mixing. Compounding. Compression moulding, injection moulding, expansion moulding. Calendering. Extrusion: melt flow, dwell times, deformations, extruder dimensioning and design, scale-up of extrusion process by the help of model theory.

Temeljna literatura in viri / Readings:

- N. G. McCrum, C. P. Buckley, C. B. Bucknall, Principles of Polymer Engineering, 2. izdaja, Oxford University Press, New York, 1997, 390 str., (80 %).
- Z. Tadmor in C. G. Gogos, Principles of Polymer Processing, John Wiley & Sons, Inc., New Jersey, 2006, 886 str., (60 %).

Cilji in kompetence:	**Objectives and Competences:**
Cilj predmeta je, da študentje osvojijo znanja o procesih in opremi na področju polimernega procesnega inženirstva. Študentje pri predmetu pridobijo naslednje specifične kompetence: - poznavanje in razumevanje matematičnih zapisov za ohranitev mase, gibalne količine in energije; - poznavanje reološkega, termodinamskega in tribološkega obnašanja materialov; - poznavanje procesov (taljenje, črpanje, mešanje, kompaundiranje, kompresijsko brizganje, injekcijsko brizganje, ekspanzijsko brizganje, kalandriranje, ekstrudiranje); - poznavanje osnov dimenzioniranja procesnih naprav v polimernem procesnem inženirstvu; - poznavanje in razumevanje povečevalnih kriterijev in modelnih teorij za ekstruzijski proces	Ability to write down and understand mathematical equations for description of conservation equations (mass, heat and momentum). Acquisition of knowledge about rheological, thermodynamic and tribological behaviour of materials. Acquisition of knowledge about processes such as melting, pumping, mixing, compounding, compression moulding , injection moulding, expansion moulding, calendering, extrusion. Acquisition of basic knowledge about equipment design in polymer engineering. Acquisition of knowledge about scale-up criteria and model theories for extrusion.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
<u>Znanje in razumevanje</u> Študent pozna procese in naprave na področju polimernega procesnega inženirstva ter razume njihovo delovanje. Razume osnove dimenzioniranja polimernih procesnih naprav.	<u>Knowledge and Comprehension</u> Acquiring knowledge about the processes and equipment used in polymer process engineering.
<u>Uporaba</u> Pridobljena znanja je sposoben uporabiti pri razvojnem in raziskovalnem delu na področju procesiranja različnih polimernih materialov ter pri uporabi in načrtovanju procesnih naprav.	<u>Application</u> Student is able to apply the knowledge at independent research and development work in the area of polymer processing and at design and use of process equipment.
<u>Refleksija</u> Študent je sposoben sintetizirati pridobljena znanja z znanji o polimernih materialih in transportnih pojavih. Pridobljeno znanje mu omogoča aktivno sodelovanje in komunikacijo s strokovnjaki z drugih tehniških ved na	<u>Analysis</u> Student is able of synthesis polymer materials and transport phenomena. Acquired knowledge enables communication with experts from other technical research.

zahtevnem področju načrtovanja procesnih naprav.	
Prenosljive spretnosti Študent je sposoben je uporabljati strokovno in (domačo in tujo) literaturo. Sposoben je zbiranja in interpretiranja podatkov. Sposoben definirati problem in ga reševati.	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, vaje.	Lectures, seminars, laboratory practice

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni in ustni izpit. 70% Seminarska naloga. 30% Opravljene laboratorijske vaje in seminarska naloga so pogoj za pristop k izpitu.		

Reference nosilca / Lecturer's references:

- LIKOZAR, Blaž, **KRAJNC, Matjaž**. Temperature dependent dynamic mechanical properties of hydrogenated nitrile butadiene rubber and the effect of peroxide cross-linkers. E-polymers. [Online ed., http://www.e-polymers.org], 2007, no. 131, str. 1-20.
- LIKOZAR, Blaž, **KRAJNC, Matjaž**. Kinetic and heat transfer modeling of rubber blends' sulfur vulcanization with N-t-butylbenzothiazole-sulfenamide and N,N-di-t-butylbenzothiazole-sulfenamide. J. appl. polym. sci., 2007, vol. 103, no. 1, str. 293-307, Graf. prikazi.
- LIKOZAR, Blaž, ŠEBENIK, Urška, **KRAJNC, Matjaž**. Modeling of dynamic mechanical properties of vulcanized fluoroelastomer. Polym. eng. sci., 2007, vol. 47, no. 12, str. 2085-2094.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	POLIMERNO REAKCIJSKO INŽENIRSTVO
Course Title:	POLYMER REACTION ENGINEERING

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

Vrsta predmeta / Course Type: izbirni strokovni / Elective Professional

Univerzitetna koda predmeta / University Course Code: IN2I06

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

Nosilec predmeta / Lecturer: prof. dr. Urška Šebenik / Dr. Urška Šebenik, 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):
- Mehanizmi polimerizacij, vplivi reakcijskega medija - Homogena radikalska polimerizacija: kinetika radikalske polimerizacije, difuzijsko kontrolirane reakcije, vrste polimerizacijskih reaktorjev, kinetično modeliranje, modeliranje porazdelitev molekulskih mas, načrtovanje reaktorjev; - Heterogene polimerizacije: suspenzijska in emulzijska polimerizacija, kinetika heterogenih polimerizacijskih procesov, transportni pojavi, vrste reaktorjev, načrtovanje procesnih naprav; - Povečevanje polimerizacijskih procesov; - Seminar in laboratorijske vaje: Obravnava izbranih integralnih polimerizacijskih procesov.	- Polymerization mechanisms, effects of reaction medium - Homogeneous free-radical polymerization: polymerization kinetics, diffusion controlled reactions, types of polymerization reactors, kinetics modelling, molecular weight distribution modelling, reactor and equipment design; - Heterogeneous polymerizations: suspension polymerization, emulsion polymerization, kinetics of heterogeneous polymerization processes, transport phenomena, types of reactors, reactor and equipment design; - Scale-up for polymerization processes; - Seminar and laboratory practice: Selected

	case studies of integrated polymerization processes.

Temeljna literatura in viri / Readings:

- Rudin, The Elements of Polymer Science and Engineering, 2nd Edition, Academic Press, London, 1999, 483 pages, (50 %).
- J. M. Asua, Polymer reaction engineering, Blackwell Publishing LTD, Oxford, 356 str. (40 %).
- N. A. Dotson, R. Galvan, R. L. Laurence, M. Tirrell, Polymerization Process Modelling, VCH, New York, 1996, 359 pages, (20 %).

Dopolnilna literatura:

- R. G. Gilbert, Emulsion Polymerization: A Mechanistic Approach, Academic Press, London, 1995, 341 pages.
- T. Meyer in J. Keurentjes, Handbook of Polymer Reaction Engineering, Wiley-VCH, Weinheim, 2005, 1083 pages.

Cilji in kompetence:	**Objectives and Competences:**
Cilj predmeta je, da študentje osvojijo pomen in vlogo reakcijskega inženirstva na področju polimerizacijskih procesov. Študentje pri predmetu pridobijo naslednje specifične kompetence: - poznavanje reakcijske kinetike polikondenzacij in vpliva procesnih pogojev na kinetiko; - poznavanje reakcijske kinetike radikalske polimerizacije in vpliva procesnih pogojev na kinetiko; - poznavanje reakcijske kinetike polimerizacijskih procesov v heterogenih sistemih; - razumevanje vpliva transporta gibalne količine, snovi in toplote na sintezo polimerov; - razumevanje modeliranja polimerizacjiskih shem; - poznavanje kinetičnega modeliranja polimerizacijskih procesov; - razumevanje uporabe matematičnih modelov za načrtovanje procesnih naprav; - razumevanje povečevalnih kriterijev, specifičnih za posamezne polimerizacijske procese.	Understanding the importance and role of reaction engineering in polymerization processes; Acquisition of knowledge about step-growth polymerization kinetics and about the effect of process parameters on kinetics; Acquisition of knowledge about chain-growth polymerization kinetics and about the effect of process parameters on kinetics; Acquisition of knowledge about kinetics in heterogeneous polymerization systems; Understanding of effects of momentum, mass and heat transport on polymer synthesis; Understanding the principles of polymerization scheme modelling; Ability to model the kinetics of polymerization processes; Understanding the implementation of mathematical models in reactor and process equipment design; Understanding the scale-up criteria for specific polymerization processes.
Predvideni študijski rezultati:	**Intended Learning Outcomes:**

Znanje in razumevanje Študent zna samostojno analizirati polimerizacijski proces in ga kvantitativno zapisati. Zapisane modele zna uporabiti za analizo, načrtovanje in optimizacijo različnih polimerizacijskih procesov.	Knowledge and Comprehension Ability of independent polymerization process analysing and quantitative describing; Ability of employing theoretical mathematical models for analysis, design and optimization of polymerization processes.
Uporaba Pridobljena znanja je sposoben uporabiti pri samostojnem razvojnem in raziskovalnem delu na področjih analize, načrtovanja in optimizacije procesov.	Application Acquired knowledge is necessary for independent research and development in the area of process analysis, design and optimization.
Refleksija Študent je sposoben samostojno sklepati, definirati problem, postavljati zaključke in probleme reševati. Znanje polimernega reakcijskega inženirstva mu omogoča aktivno sodelovanje in komunikacijo s strokovnjaki drugih tehniških in naravoslovnih ved.	Analysis Development of abilities of autonomous deducting, problem defining, problem solving, and coming to conclusions; Ability to communicate and cooperate with experts from familiar and other engineering and natural sciences.
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, vaje.	Lectures, seminars, laboratory practice.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni izpit. Opravljene vaje in seminarska naloga so pogoj za pristop k izpitu.		Written exam. Laboratory practice and project work are prerequisites to exam attendance.

Reference nosilca / Lecturer's references:

- RUČIGAJ, Aleš, ALIČ, Branko, KRAJNC, Matjaž, **ŠEBENIK, Urška**. Investigation of cure kinetics in a system with reactant evaporation : epoxidized soybean oil and maleic anhydride case study. *European Polymer Journal*, ISSN 0014-3057. [Print ed.], 2014, vol. 52, no. 1, str. 105-116. [COBISS.SI-ID 1667887]
- MOHORIČ, Ines, **ŠEBENIK, Urška**. Semibatch anionic ring-opening polymerization of octamethylcyclotetrasiloxane in emulsions : effect of the amount of seed polymer particles. *Polymer international*, ISSN 0959-8103, 2013, vol. 62, no. 7, str. 1022-1028. [COBISS.SI-ID 36249093]
- **ŠEBENIK, Urška**, KRAJNC, Matjaž. Seeded semibatch emulsion copolymerization of methyl methacrylate and butyl acrylate using polyurethane dispersion : effect of soft segment length on kinetics. *Colloids and surfaces. A, Physicochemical and Engineering Aspects*, ISSN 0927-7757. [Print ed.], 2004, vol. 233, no. 1/3, str. 51-62. [COBISS.SI-ID 25609989]

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	PROCESI V TEHNOLOGIJAH VARSTVA OKOLJA
Course Title:	ENVIRONMENTAL PROTECTION TECHNOLOGY PROCESSES

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

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: IN214

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. Andreja Žgajnar Gotvajn /
Dr. Andreja Žgajnar Gotvajn, 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):
Onesnaženje: vrste in viri onesnaženja, mehanizmi transporta, pretvorb in vplivi v okolju (voda, zrak, tla). Čiščenje onesnaženja: sodobni postopki in smeri razvoja pri čiščenju odpadnih vod, pregled konvencionalnih (koagulacija, flokulacija, adsorpcija, biološko čiščenje) in naprednih (oksidacijski procesi, katalitske in membranske tehnike) čistilnih naprav za čiščenje odpadnih vod, postopki in pregled čistilnih naprav za zrak (usedalniki, cikloni, elektrostatski precipitatorji, adsorberji, katalitski procesi), procesi remediacije in	Pollution: Types and sources, mechanisms of transport, environmental fate and impacts (water, soil, air). Pollution reduction: overwiev of up-to-date processes and methods of wastewater treatment, review of conventional (coagulation, flocculation, adsorption, biological treatment) and advanced (oxidation processes, catalytic, membrane techniques) wastewater treatment systems, processes and treatment devices for air pollution control (settling chambers, cyclones, electrostatic precipitators, scrubbers, adsorbers, catalytic combustion). Remediation

bioremediacije za čiščenje onesnaženih tal in podtalnice, tehnološki/ekonomski vzvodi vodenja in nadzora čistilnih naprav/procesov, postopki optimizacije. Okoljska ocena industrijskih procesov: politika in strategija varovanja okolja, dodatno in procesno integrirano varovanje okolja, IPPC (Integrated Pollution Prevention) direktiva, moderno upravljanje industrijskih izpustov, najboljša dostopna tehnologija BAT (Best Available Technology) - kombinacija objekta in okolja z optimalno in ekonomsko najbolj učinkovito kontrolo onesnaženja. Zakonodaja. Zmanjševanje vplivov na okolje: načini ocenjevanja vplivov procesov na okolje, pregled globalnih problemov (vzroki, ekonomske in socialne posledice, perspektive, možne rešitve), ravnanje z odpadki in načini njihove predelave, odpadek kot surovina in energent, koncept čistejše proizvodnje. Problematika fosilnih in obnovljivih virov energije.	and bioremediation processes (ground waters, contaminated soils). Proces controll, monitoring and optimization. Environmental Evaluation of Industrial Processes: policy and strategies of environmental protection, end-of-pipe measures and production-integrated environmental protection, IPPC Directive), the concepts of BAT (Best Available Technology processes, technical and economical measures to reduction of environmental impacts. Legislation. Environmental Impact Reduction: environmental impact assessmenrt approaches, global environmental problems (sources, consequences, perspectives, solutions), solid waste management and processing, waste as material and energy source, concepts of cleaner and sustainable technologies and production. Fossil and renewable sources of energy: drawbacks ans benefits.

Temeljna literatura in viri / Readings:

G. Burke, B.R. Singh, L. Theodore: Handbook of Environmental Management and Technology, Wiley, 2005, 800 pages (25%).
C.C. Lee, S.D. Lin (Eds.): Handbook of Environmental Engineering Calculations, 2nd Ed., McGraw Hill, New York, 2007, 3297 pages (15%).
Žgajnar Gotvajn, A., Kalčikova G., Zagorc-Končan, A.: Procesi v tehnologijah varstva okolja, UL FKKT, 2017 (100%)

Dodatna literatura:

G. Tchobanoglous: Wastewater Engineering: Treatment and Reuse , 4th Ed.McGraw-Hill Science/Engineering/Math, 2003, 1570 pages
J. Zagorc-Končan, A. Žgajnar Gotvajn: Zbirka nalog iz ekološkega inženirstva, UL, FKKT, 2008, 45 pages (50%).
D.T. Allen, D.R. Shonnard:Green Engineering: Environmentally Conscious Design of Chemical Processes , Prentice Hall, Englewood Cliffs, 2001, 552 pages.

Cilji in kompetence:	**Objectives and Competences:**
Pridobitev poglobljenih znanj, potrebnih za aplikativno inženirsko reševanje okoljskih problemov na področju celovitega Znanje o načinih za identifikacijo in oceno	Objectives: To acquire deep knowledge on engineering tools for solving complex environmental problems. Ability to understand and apply the principles of environmental

škodljivih na okolje okolje, znanje za sodobno upravljanje industrijskih izpustov s kombinacijo ovrednotenja tehnologije, vpliva na okolje in ocene nevarnosti za okolje. Sposobnost integracije koncepta trajnostne zaščite okolja v proizvodne, ekonomske in vodstvene odločitve.	management, science and engineering. Competences: Knowledge on identification and determination of hazardous environmental impact assessment. Knowledge on complex management of industrial emissions and cost-effective processes which minimize pollution at a source, and/or reduce impact on health and the environment. Ability to understand integrated pollution prevention practices.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
<u>Znanje in razumevanje</u> Samostojna uporaba inženirskih orodij in znanj za ekonomsko indružbeno sprejemljivo reševanje okoljskih problemov.	<u>Knowledge and Comprehension</u> Ability to apply engineering approach to solve various complex environmental problems in cost-effective manner with ethical responsibility within social context.
<u>Uporaba</u> Uporaba pridobljenih znanj pri reševanju kompleksnih inženirskih problemov. Sposobnost načrtovanja zahtevnih pristopov in eksperimentov ter ovrednotenja rezultatov, na podlagi katerih lahko načrtuje inženirske rešitve problemov.	<u>Application</u> Ability of quantification of problems and solving more complex environmental problems. Design of complex approaches and experiments and evaluation of results for design or optimisation of adequate solutions of actual problems.
<u>Refleksija</u> Razumeti svojo etično odgovornost. Kritično vrednotiti vpliv svojega dela na lokalni in globalni ravni.	<u>Analysis</u> Understand the environmental, economic and ethic consequences of technical decisions. Evaluate the work critically.
<u>Prenosljive spretnosti</u> Spretnost uporabe domače in tuje literature. Spretnost identifikacije problema in pristopa k njegovemu učinkovitemu reševanju. Spretnost izvedbe in ovrednotenje zahtevnih meritev. Uporaba ustnega in pisnega načina poročanja. Delo v skupinah.	<u>Skill-transference Ability</u> Ability to search, select and apply different types of literature. Ability to independently identify various environmental problems and search for solution. The ability to design, perform and evaluate complex measurements. Development of oral and literate skills.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
- Predavanja - Laboratorijske vaje - Projektno delo	Lectures Lab courses Project work

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Opravljene obveznosti pri vajah.	**10%**	Accomplished lab course.
Pisni in ustni izpit.	**70%**	Written and oral exam.
Projektna naloga z ustnim poročanjem.	**20%**	Presentation of the project.

Reference nosilca / Lecturer's references:

- DERCO, Ján, **ŽGAJNAR GOTVAJN, Andreja**, MENCÁKOVÁ, Angelika. Oxidative treatment of landfill leachate. V: CABRAL, Gustavo B. C. (ur.), BOTELHO, Beatriz A. E. (ur.). *Landfills : waste management, regional practices and environmental impact*, (Waste and waste management). New York: Nova Science, cop. 2012, str. 1-82.
- NAKRST, Jana, BISTAN, Mirjana, TIŠLER, Tatjana, ZAGORC-KONČAN, Jana, DERCO, Ján, **ŽGAJNAR GOTVAJN, Andreja**. Comparison of Fenton's oxidation and ozonation for removal of estrogens. *Water science and technology*, ISSN 0273-1223, 2011, vol. 63, no. 10, str. 2131-2137.
- **ŽGAJNAR GOTVAJN, Andreja**, ZAGORC-KONČAN, Jana. Combination of Fenton and biological oxidation for treatment of heavily polluted fermentation waste broth. *Acta chimica slovenica*, ISSN 1318-0207. [Tiskana izd.], 2005, vol. 52, no. 2, str. 131-137.

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	PROPAD GRADIV
Course Title:	MATERIALS DEGRADATION

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

Vrsta predmeta / Course Type: izbirni strokovni / Elective Professional

Univerzitetna koda predmeta / University Course Code: IN2I03

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

Nosilec predmeta / Lecturer: Doc. dr. Boštjan Genorio /
Dr. Boštjan Genorio, 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):
1. Uvodni del Definicija korozije, osnovna terminologija, metode obravnavanja korozijskih fenomenov, osnovne oblike korozije, gospodarske posledice korozije 2. Korozijska termodinamika in kinetika v vodnih raztopinah Elektrokemijski potencial, Pourbaixovi diagrami, Električni dvosloj, Butler-Volmerjeva enačba, Koncept mešanega potenciala, korozijski tok in potencial, procesi pasivacije 3. Korozijski mehanizmi Enakomerna, jamičasta, interkristalna, galvanska, kavitacijska, napetostna, plinska	1. Introduction Definition of corrosion, basic terminology, dealing with corrosion phenomena, forms of corrosion, impacts on the economy 2. Corrosion thermodynamics and kinetics in aqueous solutions Electrochemical potential, Pourbaix diagrams, Electrical double layer, Butler-Volmer equation, Concept of mixed potential, corrosion flow and potential, passivation processes 3. Corrosion mechanisms Uniform, pitting, intercrystalline, concentration-cell corrosion, cavitation, stress, gas corrosion, hydrogen brittleness, etc.

korozija, vodikova krhkost ipd. 4. Splošne metode proučevanja korozijskih pojavov Elektrokemijske metode (potenciodinamična, Taflova analiza, polarizacijska upornost, ciklična voltammetrija, anodna reaktivacijska plarizacija, impedančna spektroskopija), ultrazvočna metoda, optične metode, standardne metode za preiskavo specifičnih korozijskih oblik (interkristalna, kavitacijska, napetostna, špranjska) 5. Korozija in pasivacija pomembnejših kovin Železo in jekla, aluminij, cink, baker 6. Korozija polimerov 7. Korozija betonov 8. Zaščita pred korozijo I – barvni premazi 9. Zaščita pred korozijo II – galvanizacija 10. Zaščita pred korozijo III – energetski objekti 11. Zaščita pred korozijo IV – ekstremni pogoji	4. Common methods for studying corrosion Electrochemical methods (potentiodynamic, Tafel analysis, polarization resistance, cyclic voltammetry, anode reactivation polarisation, impedance spectroscopy), ultrasound method, optical methods, standard methods for testing specific forms of corrosion (intercrystalline, cavitation, stress, crevice) 5. Corrosion and passivation of major metals: Iron and steel, aluminium, zinc, copper 6. Corrosion of polymers 7. Corrosion of concrete materials 8. Corrosion protection I – paint coatings 9. Corrosion protection II – galvanization 10. Corrosion protection III – power plants 11. Corrosion protection IV – extreme conditions

Temeljna literatura in viri / Readings:

1. Corrosion – Understanding the Basics, Ed.: J.R. Davis, ASM International, Ohio, ZDA 2011, 563 strani (70%)
2. Introduction to Corrosion Science, E. McCafferty, Springer, 2010, 557 strani (30%)

Cilji in kompetence:	**Objectives and Competences:**
Cilj predmeta je, da se študentje seznanijo z mehanizmi propadanja različnih vrst gradiv (kovinskih, keramičnih, polimernih, kompozitnih) ter z najpogostejšimi praktičnimi pristopi k reševanju te problematike. Študentje si pri predmetu pridobijo naslednje specifične kompetence: - razumevanje termodinamskih principov, ki vodijo do korozijskih procesov - razumevanje korozijske kinetike, temelječe na konceptu mešanih potencialov - razumevanje kemijskih degradacijskih procesov (kemijske spremembe v betonih, polimernih materialih ipd.) - poznavanje metod za ugotavljanje hitrosti korozijskih procesov - poznavanje možnosti kontrole propada gradiv in zaščite pred njo - obvladovanje izbranih inženirskih pristopov k odpravi praktičnih korozijskih primerov	Understanding the degradation mechanisms in different materials (metallic, ceramic, polymer, composites) and common practical solutions. Subject specific competences include: - understanding the principles of thermodynamics which lead to corrosion - understanding corrosion kinetics, based on the concept of mixed potentials - understanding chemical degradation processes (chemical changes in concrete structures, polymer materials, etc.) - acquiring methods for determining the rate of corrosion - acquiring control methods for material degradation and its prevention - using appropriate engineering approaches to combate corrosion - using the knowledge in a chemical process unit - ability to deal with a specific corrosion problem by the use of literature

- usposobljenost za uporabo pridobljenega znanja v kemijskem obratu - usposobljenost za samostojno obravnavo specifičnega korozijskega problema s pomočjo ustrezne literature - usposobljenost za izdelavo poročil o ugotovljenih korozijskih procesih in posledičnih ukrepih	- ability for writing reports on corrosion and its negative impacts

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
Znanje in razumevanje Razumevanje termodinamskih in kinetičnih principov, ki vodijo do propada gradiv; Poznavanje metod za spremljanje in evalvacijo propada gradiv; Razumevanje fenomenoloških procesov in mehanizmov korozije in pasivacije kovin, propada keramičnih gradiv in polimerov; Znanje o procesih degradacije, ki potekajo na različnih tipih gradiv (kovine, keramika, polimeri, kompozitna gradiva)	Knowledge and Comprehension Understanding of thermodynamics and kinetics of corrosion. Understanding principles of testing techniques for evaluation of material degradation and its prevention. Understanding of phenomenological processes and mechanisms of corrosion, passivation of metals, degradation of ceramics and polymers. Obtaining basics of processes of degradation of various types of materials (metals, ceramics, polymers, composites).
Uporaba Obvladovanje osnovnih inženirskih protikorozijskih ukrepov za različne tipe gradiv in za različne vrste objektov; Razumevanje rezultatov splošnih korozijskih metod Sposobnost uporabe literaturnih podatkov pri reševanju konkretnih korozijskih problemov; Sposobnost povzemanja bistvene informacije iz izbranih korozijskih študij.	Application Learning basic engineering practice for corrosion prevention of various materials and devices. Application of testing techniques for evaluation of material degradation and its prevention. Ability to summarize important information from literature search and from selected corrosion studies.
Refleksija Kritična uporaba teoretičnih znanj pri interpretaciji praktičnih meritev; Kritična presoja rezultatov, pridobljenih z različnimi metodologijami.	Analysis Rational use of theory in interpretation of practical corrosion tests. Coherent evaluation of results obtained by various experimental techniques.
Prenosljive spretnosti Sposobnost identifikacije in reševanja problemov, vezanih na lastnosti gradiv; Sposobnost povzemanja bistvenih informacij iz strokovne in znanstvene literature; Sposobnost zbiranja, interpretiranja in kritičnega filtriranja (predvsem internetnih) podatkov; sposobnost podajanja pridobljenega znanja (pisanje poročil, ustne predstavitve).	Skill-transference Ability Ability for identification and solution of corrosion problems related to materials properties. Ability to collect and categorize literature (web) information and ability to present acquired knowledge in written and oral form.

Metode poučevanja in učenja:	Learning and Teaching Methods:
Predavanja (teoretične osnove, klasifikacija korozijskih oblik, podroben študij izbrani primerov propada gradiv, principi protikorozijskih pristopov) Seminar (študent skupaj s predavateljem izbere konkretno temo, pripravi pisni seminar in zagovarja seminar ustno v obliki mini konference pred predavateljem in kolegi). Predavatelj ob koncu semestra izda zbirko vseh seminarjev in jo razdeli študentom	

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Pisni in ustni izpit	80	Written and oral exam
Seminar	20	Seminar

Reference nosilca / Lecturer's references:

Genorio, B.; Lu, W.; Dimiev, A. M.; Zhu, Y.; Raji, A.-R. O.; Novosel, B.; Alemany, L. B.; Tour, J. M. In Situ Intercalation Replacement and Selective Functionalization of Graphene Nanoribbon Stacks. ACS Nano 2012, 6 (5), 4231–4240. https://doi.org/10.1021/nn300757t.

Xiang, C.; Cox, P. J.; Kukovecz, A.; Genorio, B.; Hashim, D. P.; Yan, Z.; Peng, Z.; Hwang, C.-C.; Ruan, G.; Samuel, E. L. G.; et al. Functionalized Low Defect Graphene Nanoribbons and Polyurethane Composite Film for Improved Gas Barrier and Mechanical Performances. ACS Nano 2013, 7 (11), 10380–10386. https://doi.org/10.1021/nn404843n.

Dimiev, A.; Zakhidov, D.; Genorio, B.; Oladimeji, K.; Crowgey, B.; Kempel, L.; Rothwell, E. J.; Tour, J. M. Permittivity of Dielectric Composite Materials Comprising Graphene Nanoribbons. The Effect of Nanostructure. ACS App. Mater. Interfaces 2013, 5 (15), 7567–7773. https://doi.org/10.1021/am401859j.

Genorio, B. Synthesis and Electrochemical Characterization of Graphene Nanoribbon Stacks Functionalized with Buckyballs. Acta Chim. Slov. 2015, 62, 895–901. https://doi.org/10.17344/acsi.2015.1626.

Genorio, B. The Synthesis of Diquinone and Dihydroquinone Derivatives of Calix [4] Arene and Electrochemical Characterization on Au (111) Surface. Acta Chim. Slov. 2016, 63, 496–508. https://doi.org/10.17344/acsi.2016.2289.

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Staszak-Jirkovský, J.; Malliakas, C. D. D.; Lopes, P. P. P.; Danilovic, N.; Kota, S. S. S.; Chang, K.-C.; Genorio, B.; Strmcnik, D.; Stamenkovic, V. R. R.; Kanatzidis, M. G.; et al. Design of Active and Stable Co-Mo-Sx Chalcogels as PH-Universal Catalysts for the Hydrogen Evolution Reaction. *Nat. Mater.* **2016**, *15* (November), 197–203. https://doi.org/10.1038/nmat4481.

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UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	RAZISKOVALNO DELO
Course Title:	RESEARCH WORK

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

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: IN215

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Work	Druge oblike študija	Samost. delo Individual Work	ECTS
/	**/**	**/**	**/**	**300**	**/**	**20**

Nosilec predmeta / Lecturer: /

Jeziki / Languages:

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

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Študent oz. kandidat mora imeti predmet opredeljen kot študijsko obveznost.

Prerequisites:

The course has to be assigned to the student.

Vsebina:

Raziskovalno delo se opravlja iz področja kemijskega inženirstva. Vsebina in naslov se določata v soglasju z izbranim mentorjem – nosilcem ene izmed vsebin v programu.

Content (Syllabus outline):

Research work must be carried out in the area of chemical engineering; Student may choose specific area and mentor; Contents of research work are agreed upon with the mentor, who must be a lecturer of at least one of topics of the programme.

Temeljna literatura in viri / Readings:

- knjige in članki, ki so povezani z vsebino raziskovalnega dela/ Textbooks and journal articles from the field of the research work

Cilji in kompetence:

Cilj predmeta je, da študentje s pomočjo laboratorijskega praktičnega dela uporabijo

Objectives and Competences:

Contact with experimental techniques of chemical engineering; Applying theoretical

osvojena teoretična znanja in v praksi spoznajo delovanje kemijsko inženirskih naprav, potek in vodenje procesov za namen pridobivanja oz. sinteze želenega produkta iz specifičnega področja delovanja kemijskega inženirja. Da pri tem uporabijo in osvojijo potrebne instrumentalne in druge karakterizacijske tehnike oz. metode. Da dobljene rezultate z uporabo modernih programskih paketov kvantitativno obravnavajo v skladu s teoretičnimi napovedmi. Študentje pri predmetu pridobijo naslednje specifične kompetence: - uporaba pridobljenih znanj na specifičnem področju delovanja kemijskega inženirja; - samostojno opravljanje raziskovalnega in razvojnega dela.	knowledge in practice; To get the experience in using different engineering tools and devices for process control and for product synthesis; To get the experience in using supporting instrumental and analytical techniques indispensable to collect experimental data; To get the experience in using different software packages for quantitative data analysis in accordance with theoretical predictions; Critical evaluation and presentation of the results in a scientific report. Subject specific competences are the use of theoretical knowledge in a specific area of chemical engineering and independent research and development work.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
<u>Znanje in razumevanje</u> Med opravljanjem raziskovalnega dela bo študent pridobil: - sposobnosti formuliranja problema, - sposobnosti samostojnega iskanja ustrezne literature, - sposobnosti obravnavanja problema v praksi, - sposobnosti iskanja kvantitativnih rešitev in utemeljevanja ustreznosti rešitev, - sposobnosti predstavitve rezultatov svojega dela.	<u>Knowledge and Comprehension</u> Ability of problem formulating; Ability of literature researching; Ability of problem managing in practice; Ability of quantitative problem solving and argumentation of the solution; Ability to present research results.
<u>Uporaba</u> Znanje in pridobljene veščine bo študent lahko uporabil pri opravljanju poklica in opravljanju magistrskega dela.	<u>Application</u> Acquired knowledge is necessary for Master's thesis work and for professional work.
<u>Refleksija</u> Povezovanje vseh pridobljenih teoretičnih znanj z reševanjem problemov na področju kemijskega inženirstva ter kritični pogled na uporabnost teh znanj.	<u>Analysis</u> Integration of knowledge from different topics of chemical engineering and supporting sciences; Development of a critical view on the knowledge applicability.
<u>Prenosljive spretnosti</u> Pri delu bo študent pridobil znanja o metodah reševanja kompleksnih problemov, o načinu prezentacije teh znanj v pisani in govorjeni obliki povezani z ostalimi metodami	<u>Skill-transference Ability</u> Ability of solving complex problems using different methods and skills; Ability of presenting the research work in a written and oral form.

posredovanja raziskav, ugotovitev itd.	

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Individualno delo mentorja in samostojno študijsko in raziskovalno delo.	Independent research work supervised by the mentor.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Predstavitev raziskovalnega dela. Opravljeno /neopravljeno		Pass/Fail

Reference nosilca / Lecturer's references:

/

UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	REOLOGIJA KOMPLEKSNIH TEKOČIN
Course Title:	RHEOLOGY OF COMPLEX FLUIDS

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

Vrsta predmeta / Course Type: izbirni strokovni / Elective Professional

Univerzitetna koda predmeta / University Course Code: IN2I01

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: Prof. dr. Igor Plazl / Dr. Igor Plazl, 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):
Osnove teoretične reologije in reološki principi za opredelitev različnih reoloških materialnih funkcij. Reološko obnašanje ne-newtonskih tekočin in poltrdnih snovi pod vplivom strižnega toka in strižne deformacije. Koncept notranje strukture reološko kompleksnih tekočin; molekularni in strukturni parametri, ki pogojujejo ne-newtonsko obnašanje pod vplivom strižnega toka in deformacije. Napetostni in deformacijski tenzor. Konstitutivne enačbe za opis strižnega toka in strižne deformacije. Postavitev in uporaba reoloških modelov na osnovi eksperimentalnih podatkov. Linearna viskoelastičnost, mehanski modeli. Obnašanje viskoelastičnih tekočin pri strižnih in razteznih pogojih. Prenos	Basic knowledge of theoretical rheology, rheological principles for determination material functions. Rheological behavior of non-Newtonian fluids and semi-solid materials under shear flow and shear deformation. Concept of material structure of complex fluids; molecular and structural parameters responsible for non-Newtonian behavior under shear flow and shear deformation. Stress and deformation tensors. Constitutive equations for describing shear flow and shear deformation. Determination of rheological models from experimental data and its applications. Linear viscoelasticity and mechanical models. Behaviors of viscoelastic fluids under shear and extensional flow. Application of material

materialnih reoloških funkcij v modele fluidne dinamike za opis strižnega toka. Uporaba reoloških podatkov in reoloških modelov pri načrtovanju industrijskih procesov. Uporaba rotacijskih in kapilarnih reometrov. Principi merjenja, merilne tehnike in postopki za karakterizacijo reološko kompleksnih tekočin pri (a) destruktivnih in (b) ne-destruktivnih strižnih pogojih. Opredelitev materialnih funkcij pri oscilatornih testih in testih lezenja in obnove. Povezava med in notranjo strukturo materiala in izmerjenimi viskoelastičnimi lastnostmi. Analiza in uporaba eksperimentalnih rezultatov pri razvoju novih materialov, kot kriterij kakovosti v različnih aplikacijah in kot procesni parametri v tehnoloških. Reološko obnašanje različnih skupin ne-newtonskih tekočin: - Reologija polimerov: polimerne taline, polimerne raztopine - Reologija suspenzij: visoko koncentrirane suspenzije (suspenzije keramike, pigmentne suspenzije) - Reologija šibko-gelskih struktur: (prehrambeni, farmacevtski in kozmetični izdelki) - Reologija bioloških in telesnih tekočin (kri, krvni nadomestki, slina, synovialna tekočina)	rheological functions in models of fluid dynamics for describing shear flow. Application of rheological models and experimental data in design of industrial processes. Manipulation with rotational and capillary rheometers. Principles of measurements, measuring techniques and procedures for rheological characterization of complex fluids under (a) destructive and (b) non-destructive shear conditions. Determination material functions from experimental data measured by oscillatory tests and by creep-recovery tests. Relations between internal material structures and experimentally determined viscoelastic properties. Use of measured rheological data in development of new materials, as a quality control criterion in different industrial applications and as process parameters in technological applications. Rheological characteristics of different classes of non-Newtonian fluids: Polymer rheology(melts and solutions), rheology of high solids suspensions (ceramics, pigments), rheology of weak gels, rheology of biological fluids (blood, blood substitutes, saliva, synovial fluids)

Temeljna literatura in viri / Readings:

- Uvod v reologijo, A. Zupančič Valant, 2007, Univerza v Ljubljani, FKKT, 103 str., (na voljo: UL FKKT, Katedra za kemijsko, bioekemijsko in ekološko inženirstvo), (100%)
- Rheology, Principles, Measurements and Applications", Macosco C. W., 1994, VCH Publishers, Inc., New York, 550 s (na voljo: UL FKKT, Katedra za kemijsko, bioekemijsko in ekološko inženirstvo)(20%)
- Rheology of Industrial Polysaccharides: Theory and Applications", Lapasin R., Pricl S., 1995, Blackie Academic & Professional, An Imprint of Chapman & Hall, Glasgow, 620 s(na voljo: UL FKKT, Katedra za kemijsko, bioekemijsko in ekološko inženirstvo) (20%)

Dopolnilna literatura:

- An introduction to rheology, H.A. Barnes, J. F. Hutton K.Walters, 1989, Elsevier, Amsterdam, 199s (na voljo: UL FKKT, Katedra za kemijsko, bioekemijsko in ekološko inženirstvo),
- The Structure and Rheology of Complex Fluids", Larson, R.G., 1999, Oxford University Press, Oxford, 663 s(na voljo: UL FKKT, Katedra za kemijsko, bioekemijsko in ekološko inženirstvo)
- Viscoelastic properties of polymers , J. D: Ferry 3rd edd., 1980, John & Willey¸Sons 617 s (na voljo: UL FKKT, Katedra za kemijsko, bioekemijsko in ekološko inženirstvo)

Cilji in kompetence:

Cilj predmeta je predstaviti teoretične reološke principe in uporabo različnij reoloških materialnih funkcij za opis viskoelastičnega obnašanja pri različnih strižnih in nateznih deformacijah. Nadalje je cilj predmeta predstaviti principe eksperimentalne reologije kompleksnih tekočin in poltrdnih materialov. Študent spozna definicije reoloških količin za opredelitev materialih lastnosti snovi in se nauči uporabe reološke karakterizacije ne-newtonskih tekočin pri različnih aplikacijah. Poznavanje vsebine predmeta študentu omogoči znanje o uporabnosti reoloških podatkov in pravilno izbiro reoloških modelov pri razvoju novih produktov, ali kot kriterij kakovosti procesnih materialov. Študent osvoji znanja o značilnostih reološkega obnašanja posameznih skupin procesnih materialov kot so polimeri, šibko-gelske strukture in suspenzije. Študent zna oceniti vpliv reoloških lastnosti realnih tekočin na vodenje različnih tehnoloških procesov. Študent osvoji merilne tehnike in postopke za določanje reoloških lastnosti različnih tipov strukturiranih tekočin in njihov namen.

Objectives and Competences:

To gain the knowledge about theoretical rheological principles and application of different material functions for describing viscoelastic behavior under shear and extensional conditions. To learn the principles of experimental rheology of complex fluids and semi-solid materials. To understand the rheological definitions of material functions for describing material properties and the application of rheological characterization of complex fluids in different technological cases. To gain the knowledge about applicability of rheological data and rheological models in development of new products and in quality control. To learn the methods for rheological characterization of different classes of process materials, such as polymers, suspensions, weak gels. To gain the knowledge how the rheological properties of real fluids influence on controlling of different technological processes. To learn measuring techniques and procedures examination rheological behavior of structured fluids.

Predvideni študijski rezultati:

Znanje in razumevanje

Študent pridobi znanja reologije in reometrije (strižni tok, enostavni strig, strižna hitrost, strižni modul, napetostni tenzor, viskoznost, raztezna viskoznost). Reološke podatke zna povezati z notranjo strukturo materiala in zna opredeliti viskoelastične lastnosti tekočin in poltrdnih snovi. Študent pozna pomen reoloških modelov za opis strižno odvisnega obnašanja in viskoelastičnih lastnosti materiala v različnih aplikacijah: razvoj novih produktov, opredelitev kakovosti materiala, kot procesni parametri v tehnološkem procesu. Študent pozna skupne značilnosti in pomen reologije za različne skupne procesnih materialov kot so: polimeri, suspenzije, šibko-gelske strukture in biološke tekočine.

Intended Learning Outcomes:

Knowledge and Comprehension

Student gains knowledge about rheology and rheometry (shear flow, simple shear, shear rate, shear modulus, shear tensor viscosity, extensional viscosity, etc.). Student understands relations between experimental rheological data and material internal structure and how to examine viscoelastic properties of fluids and semi-solids. Student understands the importance of application rheological models for describing shear dependent behavior in different technological situations and understands the effects of viscoelastic behavior of complex fluids in different applications: (development of new products, in quality control, as process parameters). Knowledge about common rheological characteristics of different classes of complex materials (polymers, suspensions, biological fluids).

Uporaba Poznavanje reološkega obnašanja kompleksnih tekočin in poltrdnih snovi je pomembno pri razvoju novih materialov, kot kriterij kakovosti surovin in produktov, v tehnoloških procesih, pri načrtovanju in vodenju industrijskih procesov. Študent se s praktično izvedbo reološke karakterizacije različnih ne-newtnonskih tekočin nauči pridobiti reološke podatke potrebne za različne aplikacije. Študent zna uporabiti primerne merilne tehnike in postopke za pridobitev reoloških podatkov, ki so potrebni v procesu razvoja novih produktov, ali pri načrtovanju tehnoloških procesov. Študent zna uporabiti reološke modele, oziroma njihove parametre pri načrtovanju in vodenju tehnoloških procesov. Uporaba znanja o reoloških lastnostih v posameznih skupinah procesnih materialov (polimeri, suspenzije, gelske strukture) omogoča razumevanje številnih fizikalnih zakonitosti in o poteku kemijskih reakcij.	Application Knowledge about rheological behavior of complex fluids and semi-solids is important for new materials development, for quality control in technological processes, in design and control of industrial plants. Through experimental exercises of rheological characterization of different non-Newtonian fluids student learn how to use rheological data in different applications. Student gains knowledge about measuring techniques and procedures to obtain suitable rheological data necessary for new product development, for controlling technological processes and or in industrial design and about application of rheological models and/or model parameters for controlling technological processes. Knowledge about rheological characteristics of different classes of non-Newtonian materials (polymers, suspensions, weak gels, etc.) enables understanding of various lows of physic and chemical reactions.
Refleksija Na osnovi pridobljenega teoretičnega znanja in praktičnih vaj študent pridobi občutek za ovrednotenje reoloških podatkov in spozna pomen poznavanja reoloških lastnosti pri različnih fizikalno-kemijskih zakonitostih. Študent pridobi spoznanja, da lahko reološke podatke realnih ne-newtnovskih tekočin primerja le pri sorodnih strižnih pogojih ter, da je uporaba reoloških podatkov ne-newtonskih tekočin bistvena za pravilno napoved oz. nadalnje izvrednotenje parametrov pri hidrodinamskih operacijah.	Analysis On the basis of theoretical knowledge and by experimental work student understands how to examine rheological data and recognizes the importance of knowledge of the rheological properties in several of physical and chemical processes. Student will acquire knowledge that rheological data of non-Newtonian fluids can be compared only under similar shear conditions; furthermore, that the usage of rheological data of complex fluids is essential for correct prediction and/or evaluation of hydrodynamics operations.
Prenosljive spretnosti Študent pridobi občutek za uporabo reoloških podatkov in modelov pri različnih tehnoloških procesih (mešanje, potek geliranja, pretakanje po ceveh itd.) ter kot kriterij kvalitete vstopnih in izstopnih produktov. Poznavanje reoloških lastnosti in zakonitosti posameznih skupin tehnoloških materialov (polimeri, suspenzije šibko-gelske strukture, telesne tekočine)	Skill-transference Ability Students will acquire understanding for application rheological data and models in various technological operations (mixing, pipe flow, etc.), and how the rheological data can be used as criteria in quality control (row materials, products). Student learns the relations between physical- chemical laws of real materials and their rheological properties,

omogoča povezovanje in razumevanje različnih fizikalno-kemijskih zakonitosti in se navezuje na predmete, ki vsebujejo omenjene vsebine. Na osnovi eksperimentalne vaje, utrdi teoretično znanje reometrije in reologije, spozna dejavnike, ki vplivajo na vrednosti izmerjenih reoloških količin in zna povezovati mehanske odzive snovi z njeno sestavo, torej z notranjo strukturo snovi. Uporaba različnih literaturnih virov (knjige, članki, elektronsko gradivo) omogoča preverjanje pravilnosti osnovnih reoloških konceptov, izbiro primernih reoloških modelov za popis reološkega obnašanja in povezovanje z drugimi naravoslovnimi vedami, ki kot končni rezultat prispevajo k razumevanju proučevanega procesa.	which refers to lectures of mentioned subjects. Student consolidates theoretical rheological principles and rheometry by experimental work and meets with factors that influence measured rheological data. Student understands connections between mechanical responses and material composition (internal material structure). Usage of different literature sources (books, articles, electronic sources) enable student to examine basic rheological concepts, selection of suitable rheological models for describing rheological behavior of complex fluids and to find connections with other natural sciences, which, as a final result, contribute to understand investigated process.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Predavanja, raziskovalni seminarji, individualne naloge, laboratorijske vaje.	Lectures, research seminars, individual cases, laboratory work

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Ocena poročila o opravljenih vajah, pisni kolokvij iz laboratorijskih vaj 30% Seminarska naloga, pisni in ustni izpit. 70%		

Reference nosilca / Lecturer's references:

1. M. LUBEJ, U. NOVAK, M. LIU, M. MARTELANC, M. FRANKO, **I. PLAZL**. Microfluidic droplet-based liquid-liquid extraction: online model validation, Lab Chip, 2015, 15, 223
2. POHAR, Andrej, LAKNER, Mitja, **PLAZL, Igor**. Parallel flow of immiscible liquids in a microreactor : modeling and experimental study. Microfluid. nanofluid. (Print), 2012, vol. 12, no. 1/4, str. 307-316.
3. NOVAK, Uroš, POHAR, Andrej, **PLAZL, Igor**, ŽNIDARŠIČ PLAZL, Polona. Ionic liquid-based aqueous two-phase extraction within a microchannel system. Sep. purif. technol., 2012, vol. 97, no. 1, str. 172-178.