

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, 2 nd Cycle	/	2 nd	4 th

Vrsta predmeta / Course Type: izbirni strokovni / Elective Professional

Univerzitetna koda predmeta / University Course Code: IN2111

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:

Študent oz. kandidat mora imeti predmet opredeljen kot študijsko obveznost.	Prerequisites: The course has to be assigned to the student.
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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: sustainability assesment, J.Dewulf and H. Van Langenhove, John Wiley and Sons, 2006, 339 str. (30%)

Cilji in kompetence:

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.

Objectives and Competences:

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:

Znanje in razumevanje
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.

Uporaba
S pridobljenim znanjem je študent sposoben za izbran polutant izbrati primeren proces skupaj z obratovalnimi pogoji bodisi v

Intended Learning Outcomes:

Knowledge and Comprehension
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.

Application
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.
<u>Refleksija</u> Na osnovi pridobljenega teoretičnega znanja in praktične vaje študent pridobi občutek za ovrednotenje podatkov in prenos znanja v raziskovalni in/ali tehnološki proces.	<u>Analysis</u> 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.
<u>Prenosljive spretnosti</u> 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.	<u>Skill-transference Ability</u> 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:

Predavanja, laboratorijske vaje, seminarji.

Learning and Teaching Methods:

Lectures, laboratory exercises, seminars.

Načini ocenjevanja:

Delež (v %) /

Weight (in %)

Assessment:

Pisni in ustni izpit	70	Written and oral exam.
Zaključna seminarska naloga (projektno delo)	20	Accomplished project work.
Opravljene obveznosti pri vajah	10	Accomplished lab course.

Reference nosilca / Lecturer's references:

- **ŽGAJNAR GOTVAJN, Andreja**, TRATAR-PIRC, Elizabeta, BUKOVEC, Peter, ŽNIDARŠIČ PLAZL, Polona. Evaluation of biotreatability of ionic liquids in aerobic and anaerobic conditions. Water science and technology, ISSN 0273-1223, 2014, vol. 70, no. 4, str. 698-704, ilustr., doi: 10.2166/wst.2014.283. [COBISS.SI-ID 1751855]

- KALČÍKOVÁ, Gabriela, TRATAR-PIRC, Elizabeta, **ŽGAJNAR GOTVAJN, Andreja**. Aerobic and anaerobic biodegradation potential of leachate from old active landfill. Desalination and water treatment, ISSN 1944-3994. [Print ed.], str. 1-7, ilustr. <http://www.tandfonline.com/doi/full/10.1080/19443994.2015.1024749#abstract>, doi: 10.1080/19443994.2015.1024749. [COBISS.SI-ID 1536242883]

- **ŽGAJNAR GOTVAJN, Andreja**, ZAGORC-KONČAN, Jana. Bioremediation of highway stormwater runoff. V: Conference on Protection and Restoration of the Environment IX, Kefalonia, Greece, June 30-July 3, 2008. Selected papers presented at Protection and restoration of the environment, (Desalination (Amsterdam), ISSN 0011-9164, vol. 248, no. 1/3, 2009). [S. l.: s. n.], 2009, vol. 248, no. 1/3, str. 794-802, doi: 10.1016/j.desal.2009.01.014. [COBISS.SI-ID 33289477]