

## UČNI NAČRT PREDMETA / COURSE SYLLABUS

<b>Predmet:</b>	BIOREMEDIACIJSKE TEHNOLOGIJE
<b>Course Title:</b>	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 <sup>nd</sup> Cycle	/	2 <sup>nd</sup>	4 <sup>th</sup>

**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:** doc. dr. Gabriela Kalčikova / Dr. Gabriela Kalčikova, Assistant Professor

**Jeziki / Languages:** slovenski / Slovenian  
**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: 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.
<b>Refleksija</b> Na osnovi pridobljenega teoretičnega znanja in praktične vaje študent pridobi občutek za ovrednotenje podatkov in prenos znanja v raziskovalni in/ali tehnološki proces.	<b>Analysis</b> 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.
<b>Prenosljive spretnosti</b> 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.	<b>Skill-transference Ability</b> 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	<b>70</b>	Written and oral exam.
Zaključena seminarska naloga (projektno delo)	<b>20</b>	Accomplished project work.
Opravljene obveznosti pri vajah	<b>10</b>	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