

UČNI NAČRT PREDMETA / COURSE SYLLABUS

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| Predmet: | IZBRANA POGLAVJA IZ OKOLJSKEGA INŽENIRSTVA |
| Course Title: | SELECTED TOPICS IN ENVIRONMENTAL ENGINEERING |

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

Vrsta predmeta / Course Type: izbirni/Elective

Univerzitetna koda predmeta / University Course Code: KZ317

| Predavanja Lectures | Seminar Seminar | Vaje Tutorial | Klinične vaje Work | Druge oblike študija | Samost. delo Individual Work | ECTS |
|------------------------|--------------------|------------------|-----------------------|----------------------|---------------------------------|------|
| 30 | 10 | / | / | 70 | 40 | 5 |

Nosilec predmeta / Lecturer: prof. dr. Andreja Žgajnar Gotvajn /Dr. Andreja Žgajnar Gotvajn, Full Professor

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

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

Študent oziroma kandidat mora imeti predmet opredeljen kot študijsko obveznost.

Prerequisites:

General conditions for admission to doctoral studies.

Vsebina:

Študent s soglasjem mentorja med spodaj navedenimi temami v izbere tiste, ki so najtesneje povezane z njegovim raziskovalnim delom. Sodobne tehnike identifikacije in kvantifikacije nevarnih snovi: Mikropolutanti (hormonski motilci, biocidi, PAH, PCB). In vivo in in vitro metode detekcije in kvantifikacije mikropolutantov. Sodobni postopki identifikacije in odstranjevanja nevarnih snovi v odpadnih vodah: TIE - Toxicity Identification Evaluation in TRE - Toxicity Reduction Evaluation. Sodobni trendi na področju omejevanja onesnaženja,

Content (Syllabus outline):

From the topics listed below the student selects (in agreement with the supervisor) those that are mostly related to his research work. Up-to-date techniques for qualification and quantification of hazardous substances: micro-pollutants (endocrine disrupters, biocides, PAH, PCB). In vitro and In vivo methods for detection and quantification of micro-pollutants. Advanced methods for identification and removal of hazardous substances from wastewaters: TIE – Toxicity Identification Evaluation and TRE – Toxicity Reduction Evaluation. Up-to-date trends in

sodovni koncepti ravnanja s trdnimi odpadki, ocena življenjskega cikla (LCA), principi in metode industrijske ekologije. Kemijski, membranski in biokemijski procesi v procesih zaščite, remediacije in bioremediacije okolja (voda, zrak, tla):

- Kemijski procesi: Čiščenje odpadnih in pitnih voda s kemijskimi postopki. Elektrokoagulacija. Sodobni oksidacijski procesi (AOP). Fotokatalitska oksidacija. Fentonova oksidacija. Ozonacija. Elektrokemijski procesi. Termična mokra oksidacija. Oksidacija v superkritični vodi. Akustična in hidrodinamska kavitacija. Heterogeni katalizatorji na področju varstva okolja. Katalitska mokra oksidacija. Kinetika in mehanizmi reakcij. Procesni in reaktorji. Aplikacija sodobnih oksidacijskih procesov pri odstranjevanju mikropolutantov iz zraka, tal, odpadnih in pitnih vod.
- Membranski procesi.
- Biokemijski procesi: Sodobni procesi biološkega čiščenja odpadnih vod, bioremediacija.

Integralne procesne sheme: sklopitev AOP procesov z biološkimi postopki. Sodobna slovenska in mednarodna zakonodaja s področja okolja.

pollution prevention, solid waste management, Life Cycle Analyses (LCA), principles and methods of industrial ecology. Chemical, membrane and biochemical processes for protection, bioremediation and remediation of the environment (water, air, soil):

- Chemical Processes: Treatment of wastewaters and drinking waters using chemical methods. Electrocoagulation. Advanced oxidation processes (AOPs). Photocatalytic oxidation. Fenton's oxidation. Ozonation. Electrochemical oxidation. Wet air oxidation. Supercritical water oxidation. Acoustic and hydrodynamic cavitation. Heterogenic catalysts for environmental protection. Catalytic wet oxidation. Kinetics and mechanisms of reactions. Processes and reactor systems. Application of AOPs for removal of micro-pollutants from aquatic (drinking and wastewaters) and atmospheric environments.
- Membrane Processes.
- Biochemical Processes: Up-to-date techniques for biological treatment of wastewaters, bioremediation.

Integrated process schemes: Connection of AOPs and biological processes. Slovenian and international environmental legislation.

Temeljna literatura in viri / Readings:

- S. Parsons (ur.), Advanced Oxidation Processes for Water and Wastewater Treatment, IWA Publishing, London, 2004.
- K. Boodhoo, A. Harvey (Ed.): Process Intensification for Green Chemistry, Wiley, UK, 2013.
- W.W.Eckenfelder, D.L., Ford, A.J., Engle: Industrial Water Quality, WEF Press, New York, 2009.
- Članki vodilnih revij s področja okoljskega inženirstva (npr. Journal of Hazardous Materials, Waste Management, Chemosphere, Water Research...)

Cilji in kompetence:

Študent nadgradi in poglobi znanja iz okoljskega inženirstva. Razvije sposobnost za kritično primerjavo, izbiro in optimizacijo procesov, tehnologij in izboljšav v proizvodnih in drugih postopkih. Pridobi znanje za vrednotenje vpliva svojega dela

Objectives and Competences:

Upgrading knowledge in environmental engineering, acquisition of skills for critical evaluation, selection and optimisation of processes and technologies. Assessing accomplished work in terms of the impacts on local and global environment; to solve actual

na lokalni in globalni ravni ter zavedanje o družbenem vplivu svojih odločitev v ustreznih ekonomskih, družbenih in zakonskih okvirjih.

environmental problems within economical, social and legislative limits.

Predvideni študijski rezultati:

Znanje in razumevanje

Razumevanje kompleksnih soodvisnosti in zakonitosti procesov v okolju (zrak, tla in voda) in vpliva človeka na ekosistem. Sposobnost uporabe inženirskih orodij in znanj za reševanje okoljskih problemov. Razumevanje in uporaba koncepta trajnosti, etičnih in ekonomskih načel pri načrtovanju in optimiranju procesov.

Uporaba

Sposobnost reševanja kompleksnih inženirskih problemov. Sinteza inženirskih principov in tehnik skupaj z znanjem naravoslovja za reševanje specifičnih problemov.

Refleksija

Sposobnost povezave med teorijo in problemi na lokalnem, regijskem in globalnem nivoju.

Prenosljive spretnosti

Spretnost uporabe domače in tuje literature. Sinteza znanja različnih področij. Razvoj sposobnosti povezati praktične probleme s teoretičnimi znanji. Uporaba ustnega in pisnega načina poročanja. Razvoj sposobnosti dela v skupini.

Intended Learning Outcomes:

Knowledge and Comprehension

Understanding complex relationships between processes in the environment (air, soil and water). Ability to apply engineering approach to solve a range of environmental issues. Knowledge on sustainable development approaches and their implementation at design and optimisation of industrial processes.

Application

Ability for solving complex environmental problems. Synthesis of engineering principles and techniques together with knowledge on fundamental environmental principles to solve particular problems.

Analysis

Ability to connect theoretical knowledge and actual local, regional and global environmental problems.

Skill-transference Ability

Ability to search, select and apply different types of literature. Synthesis of different fields of basic science. Ability to connect theoretical and practical approach. Development of oral and literate skills. Development of ability to work in teams.

Metode poučevanja in učenja:

Predavanja
Seminar

Learning and Teaching Methods:

Lectures
Seminar

Delež (v %) /

Načini ocenjevanja:

Weight (in %) **Assessment:**

Ustni ali pisni izpit.

60

Written or oral examination.

Izdelava seminarja, predstavitev.

40

Written seminar and its presentation.

Reference nosilca / Lecturer's references:

MARQUES, Susana, MESTRE, Ana S., MACHUQUEIRO, Miguel, ŽGAJNAR GOTVAJN, Andreja, MARINŠEK, Marjan, CARVALHO, Ana Paula. Apple tree branches derived activated carbons for the removal of β -blocker atenolol. *Chemical engineering journal*. Aug. 2018, vol. 345, str. 669-678.

BOŠEVSKI, Igor, **ŽGAJNAR GOTVAJN, Andreja**. The impact of single step ozonation of antibiotics-contaminated waste sludge to biogas production. *Chemosphere*. [Print ed.]. May 2021, vol. 271, str. 1-8.

ROZMAN, Ula, KALČÍKOVÁ, Gabriela, MAROLT, Gregor, SKALAR, Tina, **ŽGAJNAR GOTVAJN, Andreja**. Potential of waste fungal biomass for lead and cadmium removal: characterization, biosorption kinetic and isotherm studies. *Environmental technology & innovation*. May 2020, vol. 18, str. 1-9.