INDUSTRIJSKA EKOLOGIJA IN ČISTEJŠA PROIZVODNJA

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	Industrijska ekologija in čistejša proizvodnja
Course title:	Industrial Ecology And Clean Technology
Članica nosilka/UL Member:	UL FKKT

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Kemijsko inženirstvo, druga stopnja, magistrski	Ni členitve (študijski program)	1. letnik		izbirni

Univerzitetna koda predmeta/University course code:	0100740
Koda učne enote na članici/UL Member course code:	IN2I02

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
45	15	15 LV			75	5

Nosilec predmeta/Lecturer:	prof. dr. Andreja Žgajnar Gotvajn
Vrsta predmeta/Course type:	izbirni strokovni/Elective Professional

Jeziki/Languages:	Predavanja/Lectures:	Angleščina, Slovenščina
	Vaje/Tutorial:	Angleščina, Slovenščina

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 obnovljivih surovin (recikliranje, ponovna uporaba odpadnih vod, priprava površinskih vod za industrijsko izrabo, razsoljevanje, recikliranje kovin, bioplastika) in virov	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 reuse and recycling, pretretament of surface waters for industrial purposes, desalination, recycling of metals, bioplastics) and energy (biofuels, solar and wind

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.	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: 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.	Objectives: 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:**
Znanje in razumevanje Razumevanje povezav in odnosov med osvojenimi pojmi. Sposobnost vrednotenja vpliva procesov na ljudi in okolje. Znanje za izvedbo LCA in vpeljavo	Knowledge and Comprehension Understanding relationships between different terms. Ability to evaluate the impact of processes to environment and people. Knowledge on LCA

koncepta industrijske ekologije v obstoječ ali nov industrijski proces Uporaba Uporaba pridobljenih znanj pri reševanju kompleksnih inženirskih problemov. Sposobnost sinteze in interdisciplinarnega pristopa k reševanju problemov. Refleksija 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. Prenosljive spretnosti 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.	performance. Ability to implement the concept of cleaner production into new or existing industrial process. Application Ability of applying acquired knowledge for solving more complex engineering problems. Ability of interdisciplinary approach when solving of problems. Analysis 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. Skill-transference Ability 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 Field trip

Načini ocenjevanja:	**Delež/Weight**	**Assessment:**
Opravljene obveznosti pri vajah.	20,00 %	Accomplished lab course.
Pisni in ustni izpit.	50,00 %	Written and oral exam.
Zaključena seminarska naloga (projektno delo).	30,00 %	Accomplished project work.

Reference nosilca/Lecturer's references:

- KALČÍKOVÁ, Gabriela, ZUPANČIČ, Marija, JEMEC KOKALJ, Anita, **ŽGAJNAR GOTVAJN, Andreja**. The impact of humic acid on chromium phytoextraction by aquatic macrophyte Lemna minor. Chemosphere. [Print ed.]. 2016, vol. 147, str. 311-317.
- 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.
- KORICA, Predrag, CIRMAN, Andreja, **ŽGAJNAR GOTVAJN, Andreja**. Decomposition analysis of the waste generation and management in 30 European countries. Waste management & research. [Online ed.]. 2016, vol. 34, iss. 11, str. 1109-1116.