UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Ime predmeta:	TEHNOLOGIJE IN INOVACIJE ZA KROŽNO GOSPODARSTVO
Course title:	TECHNOLOGIES AND INNOVATION FOR CIRCULAR ECONOMY

Študijski program in stopnja **Study programme and cycle**	**Študijska smer** **Study option**	**Letnik** **Year of study**	**Semester** **Semester**
LOGISTIKA SISTEMOV 2. stopnja		2.	3.
SYSTEM LOGISTICS 2nd degree		2.	3.

Vrsta predmeta (obvezni ali izbirni) / **Course type (compulsory or elective)**	IZBIRNI ELECTIVE
Univerzitetna koda predmeta / University course code:	MAG

Predavanja **Lectures**	**Seminar** **Seminar**	**Vaje** **Tutorial**	**Klinične vaje** **Clinical training**	**Druge oblike študija** **Other forms of study**	**Samost. delo** **Individual work**	**ECTS**
20 e-P 20 a-P		15 e-V 25 a-V			100	6

Nosilec predmeta / Course coordinator:	**REBEKA KOVAČIČ LUKMAN**
Jeziki /Languages: **Predavanja / Lectures:**	SLOVENSKI/SLOVENE
Vaje / Tutorial:	SLOVENSKI/SLOVENE

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites for enrolling in the course or for performing study obligations:**
Ni pogojev.	None.

Vsebina (kratek pregled učnega načrta):	**Content (syllabus outline):**
1. Industrijska ekologija in krožno gospodarstvo (koncepti tehnosfere in biosfere, okoljsko načrtovanje, načela razmišljanja celostnega življenjskega cikla) 2. Materiali in tehnika za podporo krožnemu gospodarstvu (osnove o materialih in lastnosti materialov) 3. Krožno gospodarstvo v pametnih mestih (načrtovanje učinkovitih storitev, povratna logistika, alternativne rešitve z nizkimi vplivi na okolje) 4. Procesi – LCA, LCC, S-LCA kot podpora odločanju (intralogistika in pametna mesta)	1. Industrial ecology and circular economy (concepts of techno-biosphere analogy, the principles of life-cycle thinking, eco-design) 2. Materials science and engineering as a support for the circular economy (introduction to materials and their properties) 3. Circular economy in smart cities (design of efficient and effective services, reverse logistics, alternative solutions with low environmental impacts) 4. Processes – LCA, LCC, S-LCA as a support for decision-making (LCA in transport and logistics)

Temeljni literatura in viri / Reading materials:

- Gradivo in e-gradivo predmeta (skripta, zapiski predavanj, vaje, …) – še ni dostopno

- Ron Schipper & Gilbert Silvius, 2019. "Opportunities for the Circular Economy in Smart Cities: The Role of Digital Technology," International Journal of Information Systems and Social Change (IJISSC), IGI Global, vol. 10(4), pages 12-35, October.
- Ahvenniemi, H., Huovila, A., Pinto-Seppä, I., & Airaksinen, M. (2017). What are the differences between sustainable and smart cities?. *Cities*, *60*, 234-245.
- Allam, Z., & Newman, P. (2018). Redefining the smart city: Culture, metabolism and governance. *Smart Cities*, *1*(1), 4-25.
- Michael Browne, Christophe Rizet, Stephen Anderson, Julian Allen & Basile Keïta (2005) Life Cycle Assessment in the Supply Chain: A Review and Case Study, Transport Reviews, 25:6, 761-782, DOI: 10.1080/01441640500360993.
- Bach, V., Lehmann, A., Grömer M., Finkbeiner, M. (2018). Product Environmental Footprint (PEF) Pilot Phase – Comparability over Flexibility. Sustainability, 10, 12898; Doi:10.3390/su10082898.
- European Commission. (2013). EU PRODUCT ENVIRONMENTAL FOOTPRINT (PEF) GUIDE published 2013-04-09 as annex II to the Commission Recommendation on the use of common methods to measure and communicate the life cycle environmental performance of products and organisations.
- European Commission. (2016). Environmental Footprint Pilot Guidance document. Guidance for the implementation of the EU Product Environmental Footprint (PEF) during the Environmental Footprint (EF) pilot phase. Version 5.2, February 2016.
- ISO (2006a) Environmental Management – life cycle assessment – principles and framework, ISO 14040. Geneva, International Organization for Standardization.
- ISO (2006b). Environmental Management – life cycle assessment – principles and framework, ISO 14044. Geneva, International Organization for Standardization.
- Weidema B. (2017). Short procedural guideline to identify the functional unit for a product environmental footprint and to delimit the scope of product categories. Available online: https://lca-net.com/files/Granularity-guideline-FINAL_20170331.pdf (Accessed 9th April 2019).
- Klöpffer W, Grahl B (2014) Life cycle assessment (LCA): a guide to best practice. John Wiley & Sons.
- Schleiniger R (2016) Implicit CO_2 prices of fossil fuel use in Switzerland. Energy Policy 96:411–420. https://doi.org/10.1016/j.enpol.2016.06.022.

Cilji in kompetence:

Cilji predmeta:

- Izboljšati, pridobiti in poglobiti znanje iz področja industrijske ekologije, krožnega gospodarstva in zaprtih oskrbovalnih verig .
- Pridobiti nova znanja, spretnosti in veščine iz področja materialov in njihovih lastnosti.
- Predstavitev metod in tehnik za bolj uspešno sprejemanje trajnostno naravnanih odločitev na področju procesov (povezanih z intralogistiko, pametnimi mesti), z uporabo LCA, LCC, S-LCA metodologij, kot podpora odločanju.
- Izboljšati teoretično in praktično znanje na področju uvajanja inovacij in izboljšav v intralogističnih procesih in procesih pametnih mest.

Kompetence, ki jih študentke/študenti osvojijo

- Študent/ka zna sprejeti uravnoteženo odločitev o uporabi različnih materialov in snovi, na osnovi kritičnega vrednotenja

Objectives and competences:

Course objectives:

- Improve, acquire and deepen knowledge in the field industrial ecology, circular economy and closed supply chain loops.
- Acquire new knowledge, skills and capabilities in the field materials and their properties.
- Presentation of methods and techniques for more successful decision-making in the field of processes (related to intralogistics and smart cities), using LCA, LCC, S-LCA methodologies, as a decision support.
- Improve theoretical and practical knowledge in the field of introducing innovations and improvements in intralogistics and smart cities.

Compatencies that the students obtain

- The student is able to make a balanced decision on the use of different materials and substances, based on a critical evaluation.

• Študent/ka je sposoben/sposobna identificirati določiti dele, točke procesov, proizvodov, storitev, kjer se pojavljajo veliki vplivi iz vidika financ, okolja in družbenih kazalcev in poiskati ustrezne rešitve. • Študent/ka je sposobna zmodelirati logistični proces, z uporabo orodij in glede na prepoznane dele procesov uvesti izboljšave in inovacije, ki prihranijo stroške, imajo pozitivni učinek na okolje in družbene kazalce. • Študent/ka zna voditi in organizirati timsko delo, namenjeno izboljšavam in inovacijam • Študent/ka razvija spretnosti za interpretacijo pridobljenih rezultatov in sprejemanje ustreznih uravnoteženih odločitev • Študent/ka je sposoben/sposobna razpoznati različne dejavnike, ki vplivajo na izboljšanje procesov iz vseh treh vidikov (ekonomski, okoljski, družbeni). • Študent/ka je sposoben/sposobna prevzeti odgovornost za načrtovane procese in svoje odločitve.	• The student is able to identify parts, points of processes, products, services where there are major impacts are emerging from various perspectives: finances, environment and social indicators and to find appropriate solutions. • The student is able to model/design the logistics process, using tools and, depending on the identified parts of the process, to introduce improvements and innovations that save costs, have a positive effect on the environment and social indicators. • The student knows how to lead and organize teamwork to achieve improvements and innovations. • The student develops skills for interpreting the obtained results and making appropriate balanced decisions. • The student is capable to recognize various factors that affect the improvement of processes from all three aspects (economic, environmental, social). • The student is capable to take responsibility for the process design and their decisions.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Študentka/študent bo zmožna/zmožen: • razumeti načela industrijske ekologije in krožnega gospodarstva, • klasificirati, primerjati materiale, glede na potrebe procesov , • kritično vrednotiti in opredeliti prednosti in slabosti materialov , • razumeti procese načrtovanja (povezava z ekološkim-načrtovanjem), • prepoznati priložnosti in uvajati inovacije ter izboljšave v procese, sisteme, z manjšo porabo surovin in materialov, stroškov, • prepoznati priložnosti v krožnem gospodarstvu – intralogistika in pametna mesta - in sprejeti ustrezne odločitve, • načrtovati logistične procese, z uporabo LCA metod, jih modificirati ter uvajati inovacije in izboljšave v procese, na načelih krožnega gospodarstva.	The student will be capable of: • understanding the principles of industrial ecology and circular economy, • classifying, comparing the materials, • critically evaluating and defining the advantages and disadvantages of materials and evaluating the effects of materials on goods, • understanding the processes of eco-design, • recognizing opportunities and introducing innovations and improvements in processes, systems, with lower consumption of raw materials and materials, costs, • recognizing opportunities in the circular economy – intralogistics and smart cities - and making appropriate decisions, • designing logistics processes, using LCA methods, modifying them and introducing innovations and improvements into processes, based on the principles of circular economy.

Metode poučevanja in učenja:	**Learning and teaching methods:**
Predavanja: Prednost bomo dali inovativnim načinom učenja in poučevanja ter novim didaktičnim pristopom. Študenti bodo sami oblikovali predavanja (»learning by doing«, »design/create and do the real thing«), delili znanja	Lectures: We will give priority to innovative ways of learning and teaching and new didactic approaches. Students will design lectures themselves ("learning by doing", "design / create and do the real world examples"), share knowledge with peers, lectures

s sovrstniki, predavanja bodo temeljila na t.i. sodelovalnem učenju, saj bi radi v okviru predmeta dosegli najvišjo kognitivno raven razumevanja (načrtovanje, kreiranje, inoviranje). Del predavanj se bo izvajal v obliki e-predavanj. Vaje: tudi vaje bodo temeljile na realnih primerih iz okolja, kjer bodo študenti s pomočjo programske opreme načrtovali procese in proizvode v celotnem življenjskem ciklu, poiskali »pereča mesta«, predlagali inovacije in ponovno naredili simulacije procesov/proizvodov/storitev. Del vaj se bo izvajal v obliki e-vaj.	will be based on collaborative learning, as we would like to achieve the highest cognitive level of understanding (planning, creation, innovation) within the subject. Part of the lectures will be conducted in the form of e-lectures. Exercises: The exercises will also be based on real-world examples from the environment, where students will use software to design processes and products throughout the life cycle, find "hot spots", propose innovations and re-do process/product/ service simulations. Part of the exercises will be carried out in the form of e-exercises.

Načini ocenjevanja:	Delež (v %) / Share (in %)	**Assessment methods:**
Način (pisni izpit, projektna naloga): Pogoj za pristop k izpitu so obveznosti opravljene v okviru e-predavanj in e-vaj, kot tudi vaj in predavanj. Projektna naloga. Pisni izpit.	 10% 10% 30% 50%	Method (written exam, project work): The condition for taking the exam is the obligations performed in the framework of e-lectures and e-exercises, as well as exercises and lectures. Project work. Written exam.

Reference nosilca / Course coordinator's references:

ADAMCZAK, Michał, KOVAČIČ LUKMAN, Rebeka, TOBOŁA, Adrianna, TÓRZ, Maciej, CYPLIK, Piotr. Role of IoT solutions in reducing CO2 emission and road safety in car rental and car sharing market. V: KOLINSKI, Adam (ur.), DUJAK, Davor (ur.), GOLINSKA-DAWSON, Paulina (ur.). *Integration of information flow for greening supply chain management*. Cham: Springer, cop. 2020. Str. 203-217, ilustr. Ecoproduction (Berlin. Internet). ISBN 978-3-030-24355-5. ISSN 2193-4622.

VIRTIČ, Peter, KOVAČIČ LUKMAN, Rebeka. A photovoltaic net metering system and its environmental performance : a case study from Slovenia. *Journal of cleaner production*. [Online ed.]. 2019, 212, str. 334-342. ISSN 1879-1786.

VIDEGAR P., PERC, M., KOVAČIČ LUKMAN, R. A survey of the life cycle assessment of food supply chains. Journal of Cleaner Production 286(1), March 2021.

OMAHNE, V., KRAJNC, D. & KOVAČIČ LUKMAN, R. A critical overview of scientific publications on life cycle assessment in transport-related topics. *Clean Techn Environ Policy* (2020).

VIDERGAR, Petra, KOVAČIČ LUKMAN, Rebeka. Energy indicators and topics in food supply chains' life cycle assessment = Energetski kazalci in vsebine v celostnem vrednotenu okoljskih vplivov prehrambenih oskrbovalnih verig.

OBRECHT, Matevž, KNEZ, Matjaž, LISEC, Andrej, WRZALIK, Aleksandra, KOVAČIČ LUKMAN, Rebeka. Sustainable consumption and segmentation of potential low emission vehicle buyers. *System safety : human - technical facility - environment*. [Spletna izd.]. 2019, vol. 1, iss. 1, str. 425-430, ilustr. ISSN 2657-5450.

OBRECHT, Matevž, EL HADDAD, Rawan, ABD ELBARY, Rowan, KOVAČIČ LUKMAN, Rebeka, ROSI, Maja. Promoting sustainable and circular plastics use in Egipt with implementation of ecodesign principles. *System safety : human - technical facility - environment*. [Spletna izd.]. 2019, vol. 1, iss. 1, str. 441-448, ilustr. ISSN 2657-5450.

ŽIGART VERLIČ, Maja, KOVAČIČ LUKMAN, Rebeka, PREMROV, Miroslav, ŽEGARAC LESKOVAR, Vesna. Environmental impact assessment of building envelope components for low-rise buildings. *Energy*. Available online 22 August 2018, str. [1-20]. ISSN 0360-5442.

KOVAČIČ LUKMAN, Rebeka, CERINŠEK, Monika, VIRTIČ, Peter, HORVAT, Boris. Improving efficient resource usage and reducing carbon dioxide emissions by optimizing fleet management for winter services. *Journal of cleaner production*. [Online ed.]. 10. Mar. 2018, vol. 177, str. 1-11. ISSN 1879-1786.

ŽEGARAC LESKOVAR, Vesna, ŽIGART VERLIČ, Maja, PREMROV, Miroslav, KOVAČIČ LUKMAN, Rebeka. Comparative assessment of shape related cross-laminated timber building typologies focusing on environmental performance. *Journal of cleaner production*. [Print ed.]. Apr. 2019, vol. 216, str. 482-494. ISSN 0959-6526.

KOVAČIČ LUKMAN, Rebeka, VIRTIČ, Peter. Developing energy concept maps - an innovative educational tool for energy planning. *Journal of sustainable development of energy, water and environment systems*. 2018, vol. 6, iss. 4, str. 742-754. ISSN 1848-9257.

MARČIČ, Simon, KOVAČIČ LUKMAN, Rebeka, VIRTIČ, Peter. Hybrid system solar collectors - heat pumps for domestic water heating. *Thermal science*. 2018, no. 5, vol. 22, str. 2257 - 2265, ilustr. ISSN 0354-9836.

VIRTIČ, Peter, KOVAČIČ LUKMAN, Rebeka. The importance of the capacity building for implementing energy efficiency and renewable energy solutions. *Thermal science*. 2018, vol. 22, no. 5, str. 2257-2265, ilustr. ISSN 0354-9836.

BAKSA, Patrik, CEPAK, Franka, KOVAČIČ LUKMAN, Rebeka, DUCMAN, Vilma. An evaluation of marine sediments in terms of their usability in the brick industry : case study Port of Koper. *Journal of sustainable development of energy, water and environment systems*. 2017, str. 1-10. ISSN 1848-9257.

KOVAČIČ LUKMAN, Rebeka, GLAVIČ, Peter, CARPENTER, Angela, VIRTIČ, Peter, et al. Sustainable consumption and production : research, experience, and development : the Europe we want. *Journal of cleaner production*. [Print ed.]. 2016, vol. 138, str. 139-147. ISSN 0959-6526.

KOVAČIČ LUKMAN, Rebeka. Sustainable energy planning in Slovenian municipalities = Trajnostno energetsko načrtovanje v slovenskih občinah. *Journal of energy technology*. [Tiskana izd.]. oct. 2016, vol. 9, iss. 3, str. 11-25, graf. prikazi. ISSN 1855-5748.