

## UČNI NAČRT PREDMETA / COURSE SYLLABUS

**Ime predmeta:** INTRALOGISTIKA 4.0

**Course title:** INTRALOGISTICS 4.0

Študijski program in stopnja Study programme and cycle	Študijska smer Study option	Letnik Year of study	Semester Semester
LOGISTIKA SISTEMOV 3. stopnja		1.	1. in 2.
SYSTEM LOGISTICS 3 <sup>rd</sup> degree		1.	1. in 2.

**Vrsta predmeta (obvezni ali izbirni) /  
Course type (compulsory or elective)**

IZBIRNI

ELECTIVE

**Univerzitetna koda predmeta / University course code:**

DR

Predavanja Lectures	Seminar Seminar	Vaje Tutorial			Klinične vaje Clinical training	Druge oblike študija Other forms of study	Samost. delo Individual work	ECTS
20		AV	LV	RV			160	6

**Nosilec predmeta / Course  
coordinator:**

STONE LERHER

**Jeziki /Languages:**

**Predavanja / Lectures:** SLOVENSKI/SLOVENE

**Vaje / Tutorial:** SLOVENSKI/SLOVENE

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

Ni posebnih omejitev.

**Prerequisites for enrolling in the course or for  
performing study obligations:**

No special conditions.

**Vsebina (kratek pregled učnega načrta):**

- Pomen intralogistike 4.0 v logistični verigi z vidika pretočne zmogljivosti, energetske učinkovitosti, trajnosti, informacijske podpore logističnim procesom ter digitalizacije.
- Sodobni trendi v logistiki 4.0 (Industrija 4.0, Skladiščenje 4.0, Internet Stvari (IoT), Digitalizacija, Robotizacija, Umetna Inteligenca, ang. Physical Internet.
- Informacijski in materialni tok v intralogistiki 4.0.
- Skladiščni procesi v intralogistiki 4.0.
- Skladiščenje 4.0 s poudarkom na procesu Komisioniranja blaga.
- Centralno in decentralno vodeni transportno sistemi v intralogistiki 4.0.

**Content (syllabus outline):**

- The importance of intralogistics 4.0 in the logistics chain in terms of throughput capacity, energy efficiency, sustainability, information support to logistics processes and digitization.
- Modern trends in logistics 4.0 (Industry 4.0, Warehousing 4.0, Internet of Things (IoT), Digitalization, Robotization, Artificial Intelligence, Physical Internet.
- Information and material flow in intralogistics 4.0.
- Warehouse processes in intralogistics 4.0.
- Warehousing 4.0 with the emphasis on the process of Order-Picking.
- Centralised and decentralised control of transport systems in intralogistics 4.0.

<ul style="list-style-type: none"> <li>• Avtomatski in avtonomni transportno-skladiščni sistemi v intralogistiki 4.0. (ang. Automated Storage and Retrieval Systems, Shuttle-Based Storage and Retrieval Systems and Autonomous Vehicle Storage and Retrieval Systems).</li> <li>• Načrtovanje in modeliranje transportno-skladiščnih sistemov v intralogistiki 4.0 s poudarkom na: maksimalni pretočni zmogljivosti, minimalnih celotnih stroških, energetski učinkovitosti in trajnosti.</li> <li>• Več-objektna optimizacija transportno-skladiščnih sistemov v intralogistiki 4.0.</li> </ul>	<ul style="list-style-type: none"> <li>• Automatic and autonomous transport and warehousing systems in intralogistics 4.0 (Automated Storage and Retrieval Systems, Shuttle-Based Storage and Retrieval Systems and Autonomous Vehicle Storage and Retrieval Systems).</li> <li>• Design and modelling of transport and warehousing systems in intralogistics 4.0 with the emphasis on: maximum throughput capacity, minimum total cost, energy efficiency and sustainability.</li> <li>• Multi-objective optimization of transport and warehousing systems in intralogistics 4.0</li> </ul>
---	--

#### Temeljni literatura in viri / Reading materials:

<ul style="list-style-type: none"> <li>• Forger, Gary; Edwards, Charles; Ferrell, Bill; Hopper, Steve; Magliola, Dana; Schneider, Dave. (2017). Material Handling and Logistics U.S. Roadmap 2.0., Material Handling Industry of America (MHI).</li> <li>• Bartholdi, John J. &amp; Hackman, Steven T. (2017). Warehouse and distribution science, Release 0.98. The Supply Chain &amp; Logistics Institute, H. Milton Stewart School of Industrial and Systems Engineering, Georgia Institute of Technology Atlanta, USA.</li> <li>• Glock, Christoph &amp; Grosse, Eric. (2017). Warehousing 4.0 - Technische Lösungen und Managementkonzepte für die Lagerlogistik der Zukunft. B + G Wissenschaftsverlag.</li> <li>• Heinrich, Martin (2016). Transport- und Lagerlogistik: Systematik, Planung, Einsatz und Wirtschaftlichkeit. Springer Vieweg.</li> <li>• Lerher, T. (2016). Throughput and Energy Related Performance Calculations for Shuttle Based Storage and Retrieval Systems. Nova Science Publishers, USA.</li> <li>• Kagermann, Henning; Wahlster, Wolfgang; Helbig, Johannes. (2013). Recommendations for implementing the strategic initiative INDUSTRIE 4.0, National Academy of Science and Engineering, Germany.</li> <li>• Lerher, T. &amp; Šraml, M. (2012) Designing unit load automated storage and retrieval systems. V: MANZINI, Riccardo (editor). Warehousing in the global supply chain : advanced models, tools and applications for storage systems. London [etc.]: Springer. 2012, pp. 211-231.</li> </ul>
---

#### Cilji in kompetence:

<ul style="list-style-type: none"> <li>• Sposobnost povezovanja znanja sistemov intralogistike 4.0, s poudarkom na notranjem transportu, skladiščenju in komisioniranju.</li> <li>• Zmožnost za samostojno znanstvenoraziskovalno reševanje problemov načrtovanja in oblikovanja intralogistike 4.0, notranjega transporta, skladiščenja in komisioniranja.</li> </ul>
--

#### Objectives and competences:

<ul style="list-style-type: none"> <li>• Ability to integrate knowledge of intralogistics 4.0 systems, with the emphasis on internal transport, warehousing and order-picking.</li> <li>• Ability for independent scientific research solution solving for planning and designing of intralogistics 4.0, internal transport, warehousing and order-picking.</li> </ul>
--

#### Predvideni študijski rezultati:

<p>Znanje in razumevanje:</p> <ul style="list-style-type: none"> <li>• Samostojno definirati problem s področja intralogistike 4.0 in ga rešiti.</li> <li>• Kritično ovrednotiti in uporabiti napredne metode, modele, tehnike pri načrtovanju, oblikovanju in optimiranju sistemov intralogistike 4.0.</li> </ul>
--

#### Intended learning outcomes:

<p>Knowledge and understanding:</p> <ul style="list-style-type: none"> <li>• Independently define the problem in the field of intralogistics 4.0 and solve it. Critically evaluate and apply advanced methods, models, techniques by planning, design and optimization of intralogistics 4.0 systems.</li> </ul>
--

<ul style="list-style-type: none"> <li>• Uporabiti modele in metode reševanja izzivov intralogistike 4.0 tudi na ostalih področjih v gospodarstvu.</li> </ul> <p>Prenesljive/ključne spretnosti in drugi atributi:</p> <ul style="list-style-type: none"> <li>• Potrebno inženirsko znanje za načrtovanje, oblikovanje, modeliranje in optimiranje sistemov intralogistike 4.0 s poudarkom na notranjem transportu, skladiščenju in komisioniranju.</li> <li>• Poznavanje in uporaba naprednih računalniško podprtih orodjih za oblikovanje, modeliranje in optimiranje sistemov intralogistike 4.0</li> </ul>	<ul style="list-style-type: none"> <li>• Apply models and methods for solving the challenges of intralogistics 4.0 in other areas of the economy, as well.</li> </ul> <p>Transferable/Key Skills and other attributes:</p> <ul style="list-style-type: none"> <li>• The necessary engineering knowledge for planning, designing, modelling and optimizing intralogistics 4.0 systems, with an emphasis on internal transport, warehousing and order-picking.</li> <li>• The knowledge and the application of the advanced computer-aided tools for design, modelling and optimization of intralogistics 4.0 systems.</li> </ul>
--	---

#### Metode poučevanja in učenja:

<ul style="list-style-type: none"> <li>• Predavanja.</li> <li>• Konzultacije.</li> <li>• Samostojno delo.</li> <li>• Raziskovalna (projektna) naloga.</li> </ul>
--

#### Learning and teaching methods:

<ul style="list-style-type: none"> <li>• Lectures.</li> <li>• Consultations.</li> <li>• Individual work.</li> <li>• Research (project) work.</li> </ul>
---

Načini ocenjevanja:	Delež (v %) / Share (in %)	Assessment methods:
<ul style="list-style-type: none"> <li>• Raziskovalna (projektna) naloga.</li> <li>• Pisni izpit</li> </ul>	<p>50%</p> <p>50%</p>	<ul style="list-style-type: none"> <li>• Research (project) work.</li> <li>• Written examination</li> </ul>

#### Reference nosilca / Course coordinator's references:

<ol style="list-style-type: none"> <li>1. KÜÇÜKYAŞAR, Melis, EKREN, Banu Y., LERHER, Tone. <i>Cost and performance comparison for tier-captive and tier-to-tier SBS/RS warehouse configurations. International transactions in operational research, ISSN 1475-3995. [Online ed.], July 2021, vol. 28, iss. 4, str. 1847-1863. <a href="https://doi.org/ezproxy.lib.ukm.si/10.1111/itor.12864">https://doi.org/ezproxy.lib.ukm.si/10.1111/itor.12864</a>, doi: 10.1111/itor.12864. [COBISS.SI-ID 25139715], [JCR, SNIP, WoS do 9. 11. 2021: št. citatov (TC): 7, čistih citatov (CI): 6, čistih citatov na avtorja (CIAu): 2.00, Scopus do 7. 11. 2021: št. citatov (TC): 10, čistih citatov (CI): 9, čistih citatov na avtorja (CIAu): 3.00] kategorija: 1A1 (Z, A', A', A1/2); uvrstitev: Scopus (d), SCI, SSCI, Scopus, MBP; tip dela je verificiral OSICD točke: 39.34, št. avtorjev: 3</i></li> <li>2. LERHER, Tone, FICKO, Mirko, PALČIČ, Iztok. <i>Throughput performance analysis of automated vehicle storage and retrieval systems with multiple-tier shuttle vehicles. Applied mathematical modelling, ISSN 0307-904X. [Print ed.], Mar. 2021, vol. 91, str. 1004-1022, ilustr., doi: 10.1016/j.apm.2020.10.032. [COBISS.SI-ID 36277251], [JCR, SNIP, WoS do 15. 11. 2021: št. citatov (TC): 3, čistih citatov (CI): 3, čistih citatov na avtorja (CIAu): 1.00, Scopus do 8. 11. 2021: št. citatov (TC): 6, čistih citatov (CI): 6, čistih citatov na avtorja (CIAu): 2.00] kategorija: 1A1 (Z, A', A', A1/2); uvrstitev: SCI, Scopus, MBP; tip dela je verificiral OSICD točke: 44.52, št. avtorjev: 3</i></li> <li>3. AUGUSTYN, Lorenc, LERHER, Tone. <i>PickupSimulo - prototype of intelligent software to support warehouse managers decisions for product allocation problem. Applied sciences, ISSN 2076-3417, 2020, vol. 10, iss. 23, str. [1]-29, ilustr. <a href="https://doi.org/10.3390/app10238683">https://doi.org/10.3390/app10238683</a>, doi: 10.3390/app10238683. [COBISS.SI-ID 41594883], [JCR, SNIP] kategorija: 1A2 (Z, A1/2); uvrstitev: SCI, Scopus, MBP; tip dela še ni verificiran točke: 45.38, št. avtorjev: 2</i></li> </ol>
---