

**UČNI NAČRT PREDMETA/COURSE SYLLABUS**

Predmet:	INTRALOGISTIKA 4.0
Course title:	INTRALOGISTICS 4.0

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
LOGISTIKA SISTEMOV 3. stopnja		1.	1. in 2.
SYSTEM LOGISTICS 3 <sup>rd</sup> degree		1.	1. in 2.

Vrsta predmeta / Course type IZBIRNI

Univerzitetna koda predmeta / University course code: DR

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
20					160	6

Nosilec predmeta / Lecturer: TONE LERHER

Jeziki / Predavanja / Lectures: SLOVENSKI / SLOVENE  
 Languages: Vaje / Tutorial: SLOVENSKI / SLOVENE

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: Prerequisites:  
Ni posebnih omejitev. No special conditions.

**Vsebina:**

- 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, Skladičenje 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.
- Skladičenje 4.0 s poudarkom na procesu Komisioniranja blaga.
- Centralno in decentralno vodeni transportno sistemi v intralogistiki 4.0.
- 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).
- Načrtovanje in modeliranje transportno-skladiščnih sistemov v intralogistiki 4.0 s poudarkom na:

**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.
- 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).
- Design and modelling of transport and warehousing systems in intralogistics 4.0 with the emphasis on:

maksimalni pretočni zmogljivosti, minimalnih celotnih stroškov, energetski učinkovitosti in trajnosti.

- Več-objektna optimizacija transportno-skladiščnih sistemov v intralogistiki 4.0.

maximum throughput capacity, minimum total cost, energy efficiency and sustainability.

- Multi-objective optimization of transport and warehousing systems in intralogistics 4.0

#### Temeljna literatura in viri / Readings:

- 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).
- Bartholdi, John J. & Hackman, Steven T. (2017). Warehouse and distribution science, Release 0.98. The Supply Chain & Logistics Institute, H. Milton Stewart School of Industrial and Systems Engineering, Georgia Institute of Technology Atlanta, USA.
- Glock, Christoph & Grosse, Eric. (2017). Warehousing 4.0 - Technische Lösungen und Managementkonzepte für die Lagerlogistik der Zukunft. B + G Wissenschaftsverlag.
- Heinrich, Martin (2016). Transport- und Lagerlogistik: Systematik, Planung, Einsatz und Wirtschaftlichkeit. Springer Vieweg.
- Lerher, T. (2016). Throughput and Energy Related Performance Calculations for Shuttle Based Storage and Retrieval Systems. Nova Science Publishers, USA.
- Kagermann, Henning; Wahlster, Wolfgang; Helbig, Johannes. (2013). Recommendations for implementing the strategic initiative INDUSTRIE 4.0, National Academy of Science and Engineering, Germany.
- Lerher, T. & 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.

#### Cilji in kompetence:

- Podati povezana znanja sistemov intralogistike 4.0, s poudarkom na notranjem transportu, skladiščenju in komisioniranju.
- Razviti sposobnost študentov za samostojno znanstveno-raziskovalno reševanje problemov načrtovanja in oblikovanja intralogistike 4.0, notranjega transporta, skladiščenja in komisioniranja.

#### Objectives and competences:

- To provide integrated knowledge of the intralogistics 4.0 systems, with the emphasis on internal transport, warehousing and order-picking.
- To develop student's capabilities of independent scientific-research solution solving for planning and designing of intralogistics 4.0, internal transport, warehousing and order-picking.

#### Predvideni študijski rezultati:

##### Znanje in razumevanje:

- Poznavanje sistemov intralogistike 4.0 v logistični verigi s poudarkom na notranjem transportu, skladiščenju in komisioniranju.
- Znati znanstveno in raziskovalno predvideti in uporabiti napredne metode, modele, tehnike pri načrtovanju, oblikovanju in optimiranju sistemov intralogistike 4.0.
- Povezovanje teoretičnih znanj in analitičnih/numeričnih modelov pri izdelavi študij z uporabo naprednih računalniško podprtih orodij.

##### Prenesljive/ključne spretnosti in drugi atributi:

- Potrebno inženirsko znanje za načrtovanje, oblikovanje, modeliranje in optimiranje sistemov intralogistike 4.0 s poudarkom na notranjem transportu, skladiščenju in komisioniranju.
- Poznavanje in uporaba naprednih računalniško

#### Intended learning outcomes:

##### Knowledge and understanding:

- Knowledge of intralogistics 4.0 systems in the logistics chain, with the emphasis on internal transport, warehousing and order-picking.
- Knowledge of proper scientific-research anticipation and application of advanced methods, models, techniques by planning, design and optimization of intralogistics 4.0 systems.
- Integration of theoretical knowledge and analytical/numerical models in the development of studies by using advanced computer-aided tools.

##### Transferable/Key Skills and other attributes:

- The necessary engineering knowledge for planning, designing, modelling and optimizing intralogistics 4.0 systems, with an emphasis on internal transport, warehousing and order-picking.
- The knowledge and the application of the advanced

podprtih orodjih za oblikovanje, modeliranje in optimiranje sistemov intralogistike 4.0

computer-aided tools for design, modelling and optimization of intralogistics 4.0 systems.

Metode poučevanja in učenja:

- Predavanja.
- Konzultacije.
- Samostojno delo.
- Izdelava (projektne) seminarske naloge.

Learning and teaching methods:

- Lectures.
- Consultations.
- Individual work.
- Seminar (project) work.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
- Raziskovalna naloga.	50 %	- Research work.
- Izpit (teoretično in praktično znanje).	50 %	- Exam (theoretical and practical knowledge).

Reference nosilca / Lecturer's references:

1. Lerher, T., Borovinšek, M., Ficko, M., Palčič, I. (2017). Parametric study of throughput performance in SBS/RS based on simulation. *International journal of simulation modelling*, Vol. 16, No. 1, 96-107, doi: 10.2507/IJSIMM16(1)8.372.
2. Borovinšek, Matej., Ekren, Y. B., Burinskiene, A., Aurelija, Lerher, T. (2017). Multi-objective optimisation model of shuttle-based storage and retrieval system. *Transport*, ISSN 1648-4142. [Print ed.], 2017, Vol. 32, No. 2, 120-137, doi: 10.3846/16484142.2016.1186732.
3. Rosi, B., Grasic, L., Dukic, G., Opetuk, T., Lerher, T. (2016). Simulation-based performance analysis of automated single-tray vertical lift module. *International journal of simulation modelling*, Vol. 15, No. 1, 97-108. doi: 10.2507/IJSIMM15(1)8.328.
4. Lerher, T., Ekren, B. Y., Sari, Z., Rosi, B. (2016). Method for evaluating the throughput performance of shuttle based storage and retrieval systems. *Technical Gazette*, Vol. 23, No. 3, 715-723.
5. Lerher, T. (2016). Throughput and energy related performance calculations for shuttle based storage and retrieval systems, (Energy science, engineering and technology). New York: Nova Science Publishers, Inc., cop., pp 93.
6. Dukic, G., Opetuk, T., Lerher, T. (2015). A throughput model for a dual-tray Vertical Lift Module with a human order-picker. *International journal of production economics*, Vol.170, Part C, 874-881. doi:10.1016/j.ijpe.2015.04.009.
7. Lerher, T., Ekren, B. Y., Sari, Z., Rosi, B. (2015). Simulation Analysis of Shuttle Based Storage and Retrieval Systems. *International Journal of Simulation Modelling*, Vol. 14, No. 1, 48-59. doi: 10.2507/IJSIMM14(1)5.281.
8. Lerher, T. (2015). Travel time model for double-deep shuttle-based storage and retrieval systems. *International Journal of Production Research*, Vol. 54, Issue 9, 2519-2540. doi: 10.1080/00207543.2015.1061717.
9. Lerher, T. (2013). Modern automation in warehousing by using the shuttle-based technology. V: ARENT, Doug (ur.), FREEBUSH, Monica (ur.). *Automation systems of the 21st century : new technologies, applications and impacts on the environment & industrial processes*, (Engineering tools, techniques and tables). New York: Nova Publishers, Inc., pp 51-86.
10. Lerher, T., Borovinšek, M., Šraml, M. (2013). A multi objective model for optimization of automated warehouses. V: CHEUNG, Jinghua (ur.), SONG, Huan (ur.). *Logistics : perspectives, approaches and challenges*. New York: Nova Publishers. Inc., pp. 87-110.
11. Lerher, T., Šraml, M. (2012). Designing unit load automated storage and retrieval systems. V: MANZINI, Riccardo (ur.). *Warehousing in the global supply chain : advanced models, tools and applications for storage systems*. London [etc.]: Springer., pp 211-231, doi: 10.1007/978-1-4471-2274-6\_9.