| UČNI NAČRT PREDMETA/COURSE SYLLABUS | |
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| Predmet: | PRINCIPI SKLADIŠČENJA IN EMBALIRANJA |
| Course title: | PRINCIPLES OF WAREHOUSING AND PACKAGING |

| Študijski program in stopnja<br>Study programme and level | Študijska smer<br>Study field | Letnik<br>Academic year | Semester<br>Semester |
|---|---|---|---|
| LOGISTIKA SISTEMOV 2.stopnja | | 2. | 3. |
| SYSTEM LOGISTICS 2nd degree | | 2. | 3. |

Vrsta predmeta / Course type | IZBIRNI

Univerzitetna koda predmeta / University course code: | MAG
klinične vaje

| Predavanja<br>Lectures | Seminar<br>Seminar | Vaje<br>Tutorial | Klinične vaje<br>Laboratory<br>work | Druge oblike<br>študija<br>Field work | Samost. delo<br>Individ. work | ECTS |
|---|---|---|---|---|---|---|
| 15 e-p<br>30 a-P | | 13 e-V<br>21 a-V | 6 | | 65 | 5 |

Nosilec predmeta / Lecturer: | TONE LERHER

| Jeziki /<br>Languages: | Predavanja / Lectures: | SLOVENSKI / SLOVENE |
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| | Vaje / Tutorial: | SLOVENSKI / SLOVENE |

| Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti: | Prerequisits: |
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| Ni pogojev. | None. |

Vsebina:

Content (Syllabus outline):

Predavanja:

1. Uvodno poglavje – razvoj in pomen skladiščnih sistemov v transportno-skladiščni logistični funkciji.
2. Materialni tok – skladišče kot sistem čakalne vrste ("tekočinski model").
3. Operacije skladiščenja – sprejem, naročila, komisioniranje, kontrola, pakiranje, odprema.
4. Upravljanje skladiščnih sistemov – sprejem in odprema, zaloge, lastnosti, oskrba trga.
5. Skladiščna in manipulativna oprema – oprema za uskladiščenje, transporterji, sortirna oprema.
6. Vrste viličarjev – glede na principe delovanja, pogone, zmogljivosti, nosilnosti.
7. Transportni vozički – klasični, avtonomni, montažni – namenski vozički, induktivno vodeni itd.
8. Transportno skladiščne enote – palete, zaboji.
9. Oblikovanje in načrtovanje embalaže.
10. Tehnološki postopki pakiranja: vakumsko pakiranje, sterilno pakiranje, pakiranje v modificirani atmosferi, aktivno pakiranje.
11. Varovanje tovora in varno manipuliranje – pri notranjem transportu, pri transport na daljše razdalje, varno upravljanje s transportnimi sredstvi.
12. Skladiščne strategije.
13. Komisioniranje – načini, sredstva, cone.

Lectures:

1. Introduction – importance of warehouse systems in the transport-warehouse logistics function.
2. Material flow – warehouse as a queuing system ("fluid flow model").
3. Warehouse operations – receiving, process customer orders, order-picking, checking, packing, put away.
4. Warehouse management systems – receiving and shipping, stock locator system, features, market supply.
5. Storage and handling equipment – storage equipment, transporters, sorting equipment etc.
6. Types of forklifts – due to their working principles, drive motors, carrying capacity, bearing strength.
7. Transportation handcarts – classical, autonomous, assembling – special handcarts, inductive guided etc.
8. Transport storage unit – pallets, boxes etc.
9. Designing and planning of packing.
10. Technological procedures of packing: vacuum packing, sterile packing, packing in a modified atmosphere, active packing.
11. Protection of goods and safety manipulating – at interior transport, at transport on long distance, safety managing with transport devices.
12. Storage strategies.

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| 14. Oblikovanje skladiščnih sistemov – regalni skladiščni sistemi, konstrukcija skladišč, optimiranje oblike.<br><br>Seminar:<br>Seminar aplikativno dopolnjujejo vsebino predavanj s praktičnim reševanjem problemov skladiščnih sistemov. | 13. Order picking – types, equipment, zones.<br>14. Design of warehouse systems – storage rack systems, construction of the warehouse, shape optimisation.<br><br>Seminar:<br>Seminar (project) work supplement lectures with practical solutions of engineering problems concerning warehouse operations. |

Temeljni literatura in viri / Readings:

- E-gradivo predmeta.
- 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.
- 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.
- Kay, Michael G. (2016). Production system design. Department of Industrial and Systems Engineering, North Carolina State University, USA.
- Lerher, T. (2016). Throughput and Energy Related Performance Calculations for Shuttle Based Storage and Retrieval Systems. Nova Science Publishers, USA.
- 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: | Objectives and competences: |
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| - podati poglobljeno znanje s področja teorije, uporabe in pomena transportnih sistemov v kompleksnem logističnem procesu,<br>- prikazati praktično uporabo predhodno pridobljenih osnovnih znanj iz matematike, diskretnih metod, mehanike in transportne tehnike,<br>- razviti sposobnosti študentov za samostojno in kreativno reševanje problemov izbire in uporabe transportnih naprav v logističnem sistemu. | - to provide detailed knowledge of basic theory, functional use and importance of transport systems in the complex logistics process,<br>- to demonstrate practical use of previously accumulated skills of mathematics, mechanics and transport technique,<br>- to further develop student's capabilities of independent and creative solutions for transportation devices at logistics system. |

| Predvideni študijski rezultati: | Intended learning outcomes: |
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| Znanje in razumevanje:<br>- poznavanje koncepta tehniške logistike s poudarkom na skladiščenju in embaliranju,<br>- poznavanje konceptov logistične verige, principov delovanja sistemov transporta, projektnih zahtev in sledenje tovora v logističnem sistemu,<br>- povezovanje različnih znanj in postopkov ter pomena uporabe strokovne literature in računalniških sistemov za reševanje logističnih problemov. | Knowledge and understanding:<br>- knowledge of technical logistics conception with an emphasis on storage and packaging,<br>- knowledge of principles of logistics – supply chain, operation principles of transport systems, projects demands and tracking the freight in the logistics system,<br>- connection of different knowledge and procedures and importance of professional literature and computer systems for efficient solutions of logistics problems. |
| Prenesljive/ključne spretnosti in drugi atributi:<br>- povezovati uporabo različnih znanj za reševanje problemov logistike pri transportnih sistemih,<br>- izbira in načrtovanje transportnih naprav v logističnem sistemu. | Transferable/Key skills and other attributes:<br>- combined use of different fundamental skills for solution of internal transport logistics problems,<br>- selection and design of transport devices in logistics system. |

| Metode poučevanja in učenja: | Learning and teaching methods: |
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| Predavanja: pri predavanjih študent spozna teoretične vsebine predmeta. Del predavanj se izvaja na klasični način v predavalnici, del pa v obliki e-predavanj (e-predavanja se lahko izvajajo na videokonferenčni način ali s pomočjo posebej v ta namen didaktično pripravljenih e-gradiv v virtualnem elektronskem učnem okolju). | Lectures: Students understand the theoretical frameworks of the course. Part of the lecture course is in a classroom while the rest is in the form of e-learning (e-lectures may be given via video-conferencing or with the help of specially designed e-material in a virtual electronic learning environment). |
| Vaje: pri vajah študent utrdi teoretično znanje in spozna aplikativne možnosti. Del vaj se izvaja na klasični način v predavalnici, del pa v obliki e-vaj (e-vaje se lahko izvajajo na videokonferenčni način ali s pomočjo posebej v ta namen didaktično pripravljenih e-gradiv v virtualnem elektronskem učnem okolju). | Tutorials: Students enhance their theoretical knowledge and are able to apply it. Part of the seminar is in a classroom while the rest is in the form of e-learning (e-tutorials may be given via video-conferencing or with the help of specially designed e-material in a virtual electronic learning environment). |

| Načini ocenjevanja: | Delež (v %) / Weight (in %) | Assessment: |
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| • Opravljene domače in projektna naloga, | 50% | • Completed home-works and seminar (project) work, |
| • ustni izpit (teoretično in praktično znanje). | 50% | • oral examination (theoretical and practical knowledge). |
| Opravljene obveznosti e-predavanj in e-vaj so pogoj za pristop k izpitu. | | Successful completion of e-lectures and e-tutorials is a prerequisite for entering the exam. |

Reference nosilca / Lecturer's references:

1. Lerher, T. (2018). Aisle changing shuttle carriers in autonomous vehicle storage and retrieval systems. International Journal of Production Research, Vol. 56, Iss. 11, 3859-3879, doi: 10.1080/00207543.2018.1467060.
2. Ekren, B.Y., Akpunar, A., Sari, Z., Lerher, T. (2018). A tool for time, variance and energy related performance estimations in a shuttle-based storage and retrieval system. Applied mathematical modelling, Vol. 63, 109-127, https://doi.org/10.1016/j.apm.2018.06.037.
3. Lerher, T. (2018) Warehousing 4.0 by using shuttle-based storage and retrieval systems. FME Transactions, Vol. 46, Iss. 3, 381-385 doi: 10.5937/fmet1803381L.
4. 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.
5. 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.
6. 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.
7. 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.
8. 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.
9. 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.
10. 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.
11. 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.
12. 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.

13. 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.

Opomba:
Navedene sestavine so obvezna sestavina učnega načrta predmeta kot ga določajo Merila za akreditacijo visokošolskih zavodov in študijskih programov v 7. členu (Ur. l. RS, št. 101/2004).