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

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester 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 Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
15 e-p 30 a-P		13 e-V 21 a-V	6		65	5

Nosilec predmeta / Lecturer: TONE LERHER

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

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

Vsebina:

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.

Content (Syllabus outline):

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 modificated atmosphere, active packing.

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. 14. Oblikovanje skladiščnih sistemov – regalni skladiščni sistemi, konstrukcija skladišč, optimiranje oblike. 15. Modeliranje skladiščnih sistemov s poudarkom na določitvi pretočne zmogljivosti sistema. 16. Modeliranje sistemov mehanike vožnje v skladiščih s poudarkom na odporih pri gibanju in vlečnih silah. 17. Simulacijsko (diskretno) modeliranje in optimiranje (več-objektno) transportno-skladiščnih sistemov v intralogistiki. Seminar: Seminar aplikativno dopolnjujejo vsebino predavanj s praktičnim reševanjem problemov skladiščnih sistemov.	11. Protection of goods and safety manipulating – at interior transport, at transport on long distance, safety managing with transport devices. 12. Storage strategies. 13. Order picking – types, equipment, zones. 14. Design of warehouse systems – storage rack systems, construction of the warehouse, shape optimisation. 15. Modelling of warehouse systems with an emphasis on determining the throughput capacity of the system. 16. Modelling of driving system with an emphasis on movement resistance and traction forces. 17. Simulation (discrete) modelling and optimization (multi-objective) of transport-warehouse systems in intralogistics. Seminar: Seminar (project) work supplement lectures with practical solutions of engineering problems concerning warehouse operations.

Temeljni literatura in viri / Readings:

- E-lectures.
- 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., Potrč, I. (2017) Transportni sistemi v intralogistiki. Univerza v Mariboru, Fakulteta za logistiko.
- Lerher, T. (2016). Throughput and Energy Related Performance Calculations for Shuttle Based Storage and Retrieval Systems. Nova Science Publishers, USA.
- Lerher Tone (2015). Cargo securing in road transport using restraining method with top-over lashing, (Transportation issues, policies and R&D). New York: Nova Science Publishers, cop., pp 76.
- 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:
• podati poglobljeno znanje s področja teorije, uporabe in pomena transportnih sistemov v kompleksnem logističnem (skladiščnem) procesu, • prikazati praktično uporabo predhodno pridobljenih osnovnih znanj iz matematike, diskretnih metod, mehanike in transportne tehnike, • razviti sposobnosti študentov za samostojno in kreativno reševanje problemov izbire in uporabe transportnih naprav v logističnem (skladiščnem) sistemu.	• to provide detailed knowledge of basic theory, functional use and importance of transport systems in the complex logistics (warehouse) process, • to demonstrate practical use of previously accumulated skills of mathematics, mechanics and transport technique, • to further develop student's capabilities of independent and creative solutions for transportation devices at logistics (warehouse) system.

Predvideni študijski rezultati:	Intended learning outcomes:
Znanje in razumevanje: • poznavanje koncepta tehniške logistike s poudarkom na skladiščenju in embaliranju,	Knowledge and understanding: • knowledge of technical logistics conception with an emphasis on storage and packaging,

• poznavanje konceptov logistične verige, principov delovanja sistemov transporta, projektnih zahtev in sledenje tovora v logističnem sistemu, • povezovanje različnih znanj in postopkov ter pomena uporabe strokovne literature in računalniških sistemov za reševanje logističnih problemov.	• knowledge of principles of logistics – supply chain, operation principles of transport systems, projects demands and tracking the freight in the logistics system, • 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: • povezovati uporabo različnih znanj za reševanje problemov logistike pri transportnih sistemih, • izbira in načrtovanje transportnih naprav v logističnem sistemu.	Transferable/Key skills and other attributes: • combined use of different fundamental skills for solution of internal transport logistics problems, • selection and design of transport devices in logistics system.

Metode poučevanja in učenja:	Learning and teaching methods:
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). 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).	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). 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:
• 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. KÜÇÜKYAŞAR, Melis, EKREN, Banu Y., LERHER, Tone (2020). 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.]. https://doi-org.ezproxy.lib.ukm.si/10.1111/itor.12864, doi: 10.1111/itor.12864. [COBISS.SI-ID 25139715],
2. RAJKOVIĆ, Miloš, ZRNIĆ, Nenad Đ., KOSANIĆ, Nenad, BOROVINŠEK, Matej, LERHER, Tone. (2019). A multi-objective optimization model for minimizing investment expenses, cycle times and CO2 footprint of an automated storage and retrieval systems. Transport, ISSN 1648-4142. [Print ed.], vol. 34, iss. 2, str. 275-286, ilustr. https://doi.org/10.3846/transport.2019.9686, doi: 10.3846/transport.2019.9686. [COBISS.SI-ID 512990781],
3. 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.
4. 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.
5. 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.

6. 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.
7. 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.
8. 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.
9. 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.
10. 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.
11. 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.
12. 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.
13. 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.
14. 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.
15. 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).