UČNI NAČRT PREDMETA/COURSE SYLLABUS	
Predmet:	SKLADIŠČNA TEHNIKA IN TEHNOLOGIJA
Course title:	WAREHOSE TECHNICS AND TECHNOLOGY

Študijski program in stopnja **Study programme and level**	**Študijska smer** **Study field**	**Letnik** **Academic year**	**Semester** **Semester**
GOSPODARSKA IN TEHNIŠKA LOGISTIKA 1.stopnja		2.	4.
PROFESSIONAL HIGHER EDUCATION STUDY PROGRAMME ECONOMIC AND TECHNICAL LOGISTICS 1st degree		2.	4.

Vrsta predmeta (obvezni ali izbirni) /
Course type (compulsory or elective): OBVEZNI / COMPULSORY

Univerzitetna koda predmeta / University course code: VS

Predavanja Lectures	Seminar Seminar	vaje Tutorial			Klinične vaje Laboratory work	Druge oblike študija Field work	Samost. delo Individ. work	ECTS
		a-V	**e-V**	**LV**				
15 e-P **45 a-P**		**15**	**9**	**6**			**90**	**6**

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:	Content (Syllabus outline):
Materialni in informacijski tok v skladišču. Osnovni procesi skladiščenja (sprejem, skladiščenje, komisioniranje, sortiranje, združevanje, pakiranje, odprema). Transportno skladiščne enote; palete, zaboji, kontejnerji. Transportna sredstva za kontinuirani transport v skladišču (tračni transporterji, verižni transporterji, valjčni transporterji, elevatorji, polžasti transporterji, pnevmatski transporterji). Transportna sredstva za ciklični transport v skladišču (transporterji, viličarji, regalna dvigala, mostna dvigala, konzolna dvigala, dvižne mize, transportni vozički). Transportni viličarji in vlačilci (ročni viličarji, čelni viličarji, paletni viličarji, komisionirni viličarji, regalni viličarji, visokoregalni viličarji, štiri-potni viličarji, avtomatsko vodeni vozički AGV). Skladiščna tehnika za palete (talno skladiščenje, paletni regali, stebrni regali, pretočni regali, povratno pretočni	Material and informational flow in warehouse. Basic warehouse process (receiving, storage, order-picking, sorting, unitizing, packaging, shipping). Transport unit load; pallet, totes, containers. Material handling systems for continuous transport in warehouse (belt conveyors, chain conveyors, roller conveyors, elevators, screw conveyors, pneumatic conveyors). Material handling systems for discrete transport in warehouse (conveyors, forklift trucks, storage and retrieval machines, industrial cranes, cantilever cranes, lifting tables, shuttle carriers). Industrial trucks and carriers (pallet jack, counterbalanced lift trucks, pallet trucks, order-picking trucks, narrow-aisle trucks, high-bay trucks, side-loaders, automated guided vehicles AGV). Storage technique for pallets (block stacking, storage racks, pallet flow racks, drive-in racks, push-back rack,

regali, konzolni regali, prevozni regali, "Crossdocking", paletni avtomatizirani regalni skladiščni sistemi). Skladiščna tehnika za kartone/zaboje (polični regali, pretočni regali, horizontalni karusel, avtomatizirani regalni skladiščni sistemi majhnih delov, avtomatizirani regalni skladiščni sistemi z avtomatsko vodenimi vozički). Skladiščna tehnika za posamezne artikle (skladiščne omare, vertikalni skladiščni moduli, skladiščni sistemi "A-frame", polični regali, vertikalni karuseli, pretočni regali). Posebne izvedbe regalne opreme (samonosna regalna konstrukcija, jekleni podesti). Skladiščne strategije (naključna, namenska in skladiščna strategija na osnovi skladiščnih con). Komisioniranje (Komisionar-k-Blagu in Blago-h-Komisionarju). Ravni komisioniranja (komisioniranje zaključenih palet, komisioniranje kartonov/zabojev z artikli, komisioniranje artiklov). Komisioniranje palet (komisioniranje palet z viličarjem, regalnim in visokoregalnim viličarjem ter z regalnim dvigalom). Komisioniranje kartonov/zabojev (komisioniranje kartonov z viličarjem na paleto, na tračni transporter, komisioniranje zabojev v avtomatiziranem regalnem skladišču majhnih delov in v avtomatiziranem regalnem skladiščnem sistemu z avtomatsko vodenimi vozički). Komisioniranje artiklov (komisioniranje posameznih artiklov iz komisionirnih omar, vertikalnih skladiščnih modulov, skladiščnih sistemov "A-frame", poličnih regalov, vertikalnih karuselov, pretočnih regalov). Metode komisioniranja (samostojno, v skladiščni coni, več delovnih nalogov skupaj, združeno). Komisionirne strategije (S-strategija, povratna strategija, strategija srednje točke, združena strategija, optimalna strategija). Posebne oblike komisionirnih sistemov (VDI združenje). Tehnologije komisioniranja (papirno, RF terminal in črtna koda, "Pick-by-voice", "Pick-to-light", "Pick-by-Vision"). Upravljanje zalog v skladišču. Vzdrževanje skladiščnih, transportnih in manipulativnih sredstev. Poznavanje standarda GS1 v skladiščnem poslovanju. Tiskanje identifikacijskih kod in označevanje izdelkov. Industrijski in kolaborativni roboti: osnovne komponente, osnovne konfiguracije, osnovna prijemala, osnovno programiranje robotov. Mobilni roboti (avtonomna oz. avtomatsko vodena vozila): uporaba mobilnih robotov v logistiki, osnovne konfiguracije, varnostni laserski skenerji, pregled komercialnih rešitev.	cantilever racks, sliding racks, crossdocking, unit-load automated storage and retrieval systems). Storage technique for packages (full cartons) and totes (bin shelving, carton flow racks, horizontal carousels, mini-load automated storage and retrieval systems, shuttle-based storage and retrieval systems). Storage technique for individual pieces (storage drawers, vertical lift modules, A-frames, bin shelving, vertical carousels, carton flow racks). Special design of storage equipment (self-sustaining storage construction, mezzanine). Storage strategies (random, dedicated, clase-based). Order-picking (Picker-to-Parts, Parts-to-Picker). Levels of Order-Picking (pallet picking, case picking, item picking). Pallet picking (order-picking of pallet with industrial truck, order-picking and narrow-aisle truck, and with storage and retrieval machine). Case/tote picking (order-picking of cases with industrial truck on a pallet, on a belt conveyor, order-picking of totes in mini-load automated storage and retrieval systems and in shuttle-based storage and retrieval systems). Item picking (order-picking of individual items from storage drawers, vertical lift modules, A-frame, bin shelving, vertical carousels, and carton flow racks). Methods of order-picking (Discrete, Zone, Batch, Zone-Batch). Order-picking strategies (S-shape, Return, Mid-point, Combined, Optimal). Special designs of order-picking systems (VDI association). Order-picking technologies (paper, RF terminal with bar code, Pick-by-voice, Pick-to-light, Pick-by-Vision). Warehouse Inventory Management. Maintenance of storage and material handling equipment. Knowledge of GS1 standard in warehouse operation. Printing of identification codes and labelling of the products. Industrial and collaborative robots: basic components, basic configurations, basic grippers, basic robot programming. Mobile robots (autonomous or automated-guided vehicles): mobile robots in logistics, basic configurations, safety laser scanners, commercial solutions.

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.
- Lerher, T., Potrč, I. (2017) Transportni sistemi v intralogistiki. Univerza v Mariboru, Fakulteta za logistiko.
- 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 B.M. (2016) Lecture Notes for Production system design, North Carolina State University, USA.
- Gudehus, T. (2012) Logistik 1: Grundlagen, Verfahren und Strategien, Springer Verlag, Berlin.
- Arnold, D. (2002) Handbuch Logistik, Berlin, Springer Verlag, ISBN: 3-540-41996-9, COBISS.SI-ID: 24234757.

Cilji in kompetence:

Študenti bodo v okviru tega predmeta:
- spoznali osnove in pomen skladiščenja in komisioniranja ter skladiščnega poslovanja v različno organiziranih skladiščnih sistemih,
- znali izdelati načrt organizacije poslovanja skladiščnega sistema,
- znali samostojno reševati izzive načrtovanja skladiščnih sistemov v praksi.

Objectives and competences:

In the framework of this subject, the students will:
- know the basis and the meaning of warehousing and order-picking and warehouse activity of different organized warehouse systems,
- know to develop a plan for operating rules of warehousing system,
- know to independently solve challenges of designing warehouse systems in practice.

Predvideni študijski rezultati:

Po opravljenem izpitu bodo študentje znali:
- povezati uporabo različnih znanj za reševanje problemov skladiščenja in izbire transportno-skladiščne opreme,
- uporabiti algoritme upravljanja transportno-skladiščnih sistemov,
- pridobljeno znanje uporabiti pri načrtovanju komisionirnih in transportno-skladiščnih sistemov,
- uporabiti različna tehniška znanja in modele ter strokovno literaturo za načrtovanje in oblikovanje komisionirnih in transportno-skladiščnih sistemov.

Intended learning outcomes:

Upon passing the exam, students will be able to:
- connect different fundamental skills for problem solution of warehousing and transport and warehouse equipment selection,
- use the algorithms for the management of transport and warehouse systems,
- use the acquired knowledge for planning order-picking, transport and warehouse systems,
- use of different technical knowledge, models and professional literature for planning and design of order-picking, transport and warehouse systems.

Metode poučevanja in učenja:

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).

Learning and teaching methods:

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 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.

▪ Pisni izpit. ▪ Ustni izpit.	50% 50%	▪ Written exam. ▪ Oral 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. [Online ed.]. ISSN 1475-3995. https://doi-org.ezproxy.lib.ukm.si/10.1111/itor.12864, DOI: 10.1111/itor.12864.
2. Rajković, Miloš; Zrnić, N. Đ.; Kosanić, N; Borovinšek, M.; Lerher, T. (2019). A multi-objective optimization model for minimizing investment expenses, cycle times and CO2 footprint of an automated storage and retrieval systems. Transport, Vol. 34, iss. 2, 275-286, doi: 10.3846/transport.2019.9686.
3. Lerher, Tone. (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, Banu Y., Akpunar, Anil, Sari, Zaki, Lerher, Tone. (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. 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.
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., 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.
9. Lerher, T., EDL, M., Rosi, B. (2013) Energy efficiency model for the mini-load automated storage and retrieval systems. The international journal of advanced manufacturing technology, Vol. 70, No. 1/4, 97-115, doi: 10.1007/s00170-013-5253-x.