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

Študijski program in stopnja **Study programme and cycle**	**Študijska smer** **Study option**	**Letnik** **Year of study**	**Semester** **Semester**
GOSPODARSKA IN TEHNIŠKA LOGISTIKA 1. stopnja		2.	3.
PROFESSIONAL HIGHER EDUCATION STUDY PROGRAMME ECONOMIC AND TECHNICAL LOGISTICS 1st degree		2.	3.

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** **Clinical training**	**Druge oblike študija** **Other forms of study**	**Samost. delo** **Individual work**	**ECTS**
20 e-P 40 a-P		**a-V**	**e-V**	**LV**			90	6
		15	5	10				

Nosilec predmeta / Course coordinator:	**TONE LERHER**
Jeziki /Languages: **Predavanja / Lectures:**	SLOVENSKI/SLOVENE
Vaje / Tutorial:	SLOVENSKI/SLOVENE

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	**Prerequisites for enrolling in the course or for performing study obligations:**
Ni pogojev.	None.

Vsebina (kratek pregled učnega načrta):	**Content (syllabus outline):**
1. Materialno informacijski tok ter osnovni skladiščni procesi. 2. Transportna sredstva za kontinuirani in ciklični transport v skladiščih. 3. Transportni viličarji, AGV in AMR. 4. Skladiščna tehnika za palete, kartone/zaboje in posamezne artikle. 5. Komisioniranje "komisionar-k-blagu" in "blago-h-komisionarju". 6. Tehnologije komisioniranja. 7. Vzdrževanje skladiščnih in manipulativnih sredstev.	1. Material and information flow and basic warehouse processes. 2. Material handling systems for continuous and discrete transport in warehouses. 3. Industrial trucks and vehicles. 4. Storage technique for pallets, packages/totes and individual pieces. 5. Order-picking. 6. Order-picking technologies. 7. Maintenance of storage and material handling devices. 8. Cargo securing in transport between warehouses.

8. Varovanje tovora v medskladiščnem transportu.	

Temeljni literatura in viri / Reading materials:

- E-gradivo predmeta.
- Lerher, T. (2021). Skladiščno-komisionirni sistemi. Univerza v Mariboru, Fakulteta za strojništvo.
- Lerher, T. (2021). Avtomatsko vodeni in avtonomni vozički ter mobilni roboti v intralogistiki. Univerza v Mariboru, Fakulteta za strojništvo.
- Lerher, T., Potrč, I. (2017). Transportni sistemi v intralogistiki. Univerza v Mariboru, Fakulteta za logistiko.
- Bartholdi, J. J. & Hackman, S. T. (2019). Warehouse and distribution science, Release 0.98.1 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.
- Ten Hompel, M., Sadowsky, V., Beck, M. (2011). Kommissionierung, Materialflusssysteme 2 - Planung und Berechnung der Kommissionierung in der Logistik, Springer-Verlag Berlin Heidelberg.
- Ten Hompel, M., Schmidt, T. (2010). Warehouse Management, Organisation und Steuerung von Lager- und Kommissioniersystemen, Springer-Verlag Berlin Heidelberg.
- Glock, Christoph & Grosse, Eric. (2017). Warehousing 4.0: Technische Lösungen und Managementkonzepte für die Lagerlogistik der Zukunft, B + G Wissenschaftsverlag.

Cilji in kompetence:

Cilji predmeta:

- opredeliti pomen skladišča v intralogistiki,
- predstaviti tehnično-tehnološke rešitve za učinkovito izvajanje skladiščnih procesov s poudarkom na procesu komisioniranja,
- predstaviti primer načrtovanja in analize učinkovitosti komisionirno-skladiščnih sistemov,
- pojasniti prednosti uporabe avtomatiziranih rešitev v skladiščih,
- opredeliti pomen vzdrževanja skladiščnih in manipulativnih sredstev ter varovanja tovora v medskladiščnem transportu,
- opredeliti sistematični pristop pri reševanju izzivov skladiščnih sistemov v praksi.

Kompetence, ki jih študentje osvojijo:

- spoznati in razumeti delovanje različnih skladiščnih sistemov v praksi,
- se usposobiti za načrtovanje in analizo učinkovitosti komisionirno-skladiščnih sistemov,
- se usposobiti za izbiro in implementacijo različne skladiščne tehnike in tehnologije,
- se usposobiti za izbiro ustreznega transportnega sredstva pri procesih prevzema, uskladiščenja, komisioniranja in odpreme.

Objectives and competences:

Objectives:

- define the meaning of the warehouse in intralogistics,
- present technical-technological solutions for an efficient implementation of storage processes with a focus on the order-picking process,
- present an example of planning and analysing the efficiency of order-picking and storage systems,
- explain the advantages of using automated solutions in warehouses,
- define the importance of maintaining storage and handling devices and cargo securing in transport between warehouses,
- define a systematic approach to solving storage system challenges in practice.

Competences that students acquire:

- learn about and understand how different storage systems work in practice,
- gain the ability to plan and to analyse the efficiency of order-picking and storage systems,
- gain the ability to select and to implement different storage techniques and technologies,
- gain the ability to select the appropriate means of transportation in the processes of receiving, storing, order-picking, and shipping,
- gain the ability to develop a project plan for a warehouse and to analyse material flows,

• se usposobiti za izdelavo projektnega plana skladišča ter analizirati materialne tokove, kapaciteto in pretočno zmogljivost skladišča, • se usposobiti za učinkovito izvajanje procesa vzdrževanja skladiščnih in manipulativnih sredstev, • se usposobiti za izbiro metod pri načrtovanju varovanja tovora v medskladiščnem transportu.	storage volume, and throughput performance of the warehouse, • gain the ability to effectively implement the process of maintaining storage and handling devices. • gain the ability to select methods of planning cargo securing in transport between warehouses.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Študent je ob zaključku predmeta zmožen: • uporabiti ustrezno skladiščno tehniko in tehnologijo pri načrtovanju skladišča, • načrtovati, analizirati in ovrednotiti uporabo izbrane transportno skladiščne tehnike za učinkovito poslovanje skladišča, • načrtovati prostorsko razvrstitev "layout" skladišča, • uporabiti osnovne modele in tehnična priporočila (VDI, FEM) pri načrtovanju skladišč, • uporabiti metode za učinkovito izvajanje procesa vzdrževanja skladiščnih in manipulativnih sredstev, • zagotoviti varnost tovora v medskladiščnem transportu z uporabo metod proti zdrsu in prevračanju tovora.	At the end of the course, the student is able to: • use appropriate storage techniques and technologies in warehouse planning, • plan, analyse and evaluate the use of the selected transport and storage technology for the efficient operation of the warehouse, • plan the layout of the warehouse, • use basic models and technical guidelines (VDI, FEM) for the design of warehouses, • use methods to effectively implement the process of maintaining storage and handling devices, • ensure the safety of cargo in transport between warehouses by using methods to prevent the cargo from slipping and tipping.

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 laboratoriju, 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 laboratory 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 %) / Share (in %)	**Assessment methods:**
• 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.	40% 50%	• Written examination.

• Ustni izpit. • Poročilo o laboratorijskih vajah.	10%	• Oral exam. • Laboratory exercise report.

Reference nosilca / Course coordinator's references:

1. Jerman, Boris; Ekren, Banu Y., KÜÇÜKYAŞAR, Melis, Lerher, Tone. (2021). Simulation-based performance analysis for a novel AVS/RS technology with movable lifts. Applied sciences. vol. 11, iss. 5, pp 1-14, DOI: 10.3390/app11052283.
2. Lorenc, Augustyn; Lerher, Tone. (2020). PickupSimulo - prototype of intelligent software to support warehouse managers decisions for product allocation problem. Applied sciences. vol. 10, iss. 23, pp 1-29, DOI: 10.3390/app10238683.
3. 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.
4. 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.
5. 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.
6. 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.
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.