UČNI NAČRT PREDMETA / COURSE SYLLABUS

Ime predmeta:	TEORIJA OPTIMIZACIJE IN NAČRTOVANJE MODELOV V PAMETNIH LOGISTIČNIH SISTEMIH
Course title:	THEORY OF OPTIMIZATION AND MODELING DESIGN IN SMART LOGISTIC SYSTEMS

Študijski program in stopnja Study programme and cycle	Študijska smer Study option	Letnik Year of study	Semester Semester
LOGISTIKA SISTEMOV 2. stopnja		2.	4.
SYSTEM LOGISTICS 2nd degree		2.	4.

Vrsta predmeta (obvezni ali izbirni) / **Course type (compulsory or elective)**	IZBIRNI ELECTIVE

Univerzitetna koda predmeta / University course code: MAG

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Clinical training	Druge oblike študija Other forms of study	Samost. delo Individual work	ECTS
28 a-P 12 e-P		28 a-V 12 e-V			100	6

Nosilec predmeta / Course coordinator:	**DRAGAN DEJAN**

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. Optimizacija pametnih logističnih sistemov in optimizacijski modeli (zvezna in diskretna, projektne spremenljivke, eno-in več-objektna funkcijska optimizacija, omejitve, modeliranje optimizacijskih problemov in optimizacijski modeli, numerična orodja).	1. Optimization of smart logistics systems and optimization models (continuous and discrete, decision variables, single- and multi-objective functional optimization, constraints, modeling of optimization problems and optimization models, numerical tools).
2. Klasične in moderne optimizacijske metode in algoritmi (eksaktne metode, aproksimacijske metode, hevristični algoritmi, problemsko specifične hevristike, meta-hevristike, genetski algoritmi, kolonija mravelj, simulirano ohlajanje).	2. Classical and modern optimization methods and algorithms (exact methods, approximation methods, heuristic algorithms, problem-specific heuristics, meta-heuristics, genetic algorithms, ant colony, simulated annealing).
3. Statistični regresijski modeli in napovedovanje časovnih vrst v pametnih logističnih sistemih (regresijski modeli, modeli linearnih in nelinearnih časovnih vrst, hibridni modeli, problematika izbire optimalnih modelov,	3. Statistical regression models and time series prediction in smart logistics systems (regression models, linear and nonlinear time series models, hybrid models, optimal model selection problems, use of appropriate numerical tools, forecasting in smart systems).

uporaba ustreznih numeričnih orodij, napovedovanje v pametnih sistemih). 4. Matematično modeliranje prometnih tokov v pametnih logističnih sistemih (makroskopski "stream" modeli, modeli stacionarnega toka, makroskopski zvezni modeli prometa, modeliranje zastojev in ozkih grl, množična strežba in čakalne vrste pri modeliranju prometa).	4. Mathematical modeling of traffic flows in smart logistics systems (macroscopic "stream" models, stationary flow models, macroscopic continuous traffic models, modeling of congestion, bottlenecks, and other shocks, waiting lines, mass service and queues in traffic modeling).

Temeljni literatura in viri / Reading materials:

E-gradivo predmeta.

Arora, R. K. Optimization: Algorithms and Applications; CRC Press, 2015.

Box, G. E. P., Jenkins, G. M., Reinsel, G. C., et al. 2015. Time Series Analysis: Forecasting and Control: John Wiley & Sons.

DRAGAN, Dejan. Optimizacija logističnih procesov : visokošolski učbenik. Celje: Fakulteta za logistiko, 2010. 1 optični disk (CD-ROM), barve. ISBN 978-961-6562-40-9 . [COBISS.SI-ID 252279808].

DRAGAN, Dejan. Upravljanje logističnih sistemov : visokošolski učbenik. Celje: Fakulteta za logistiko, 2009. 434 str., ilustr. ISBN 978-961-6562-31-7 . [COBISS.SI-ID 246006272].

DRAGAN, Dejan. Modern optimization methods, models, metaheuristics, and their role in logistics and supply chains : material of the subject Modeling principles in logistics : graduate study. 1. izd. Celje: Fakulteta za logistiko, 2020. [115] str., ilustr. http://estudij.um.si/. [COBISS.SI-ID 513119037].

DRAGAN, Dejan. Principi modeliranja v logistiki : visokošolski učbenik. Celje: Fakulteta za logistiko, 2010. 1 CD-ROM. [COBISS.SI-ID 512264509].

DRAGAN, Dejan. Statistika in uvod v regresijske modele v Matlabu pri optimizaciji logističnih procesov : visokošolski učbenik. 1. izd. Celje: Fakulteta za logistiko, 2014. 801 str. http://blend.fl.uni-mb.si/. [COBISS.SI-ID 80939521].

Leutzbach, W. 2012. Introduction to the Theory of Traffic Flow: Springer Science & Business Media.

Talbi, E.-G. *Metaheuristics: From Design to Implementation*; John Wiley & Sons, 2009.

Cilji in kompetence:	**Objectives and competences:**
Cilji predmeta so: • osvojiti in razumeti pojme in znanja s področja optimizacije in načrtovanja modelov pametnih logističnih sistemov (PLS), • pravilno identificirati probleme s tega področja in pridobiti znanja za konstrukcijo modelov in uporabo optimizacijskih metod in algoritmov, • razumeti mehanizme delovanja optimizacijskih metod in načrtovanih modelov in jih znati pravilno uporabiti za reševanje problemov, • pridobiti znanja pravilne klasifikacije različnih problemov in zmožnosti uporabe pravilnih in ustreznih postopkov optimizacije in pristopov k načrtovanju modelov za dani problem, • pridobiti razumevanje teoretičnih ozadij, nujno potrebnih za pravilno interpretacijo dobljenih rezultatov optimizacije in načrtovanih modelov in ocenitev kakovosti razvitih metod in modelov,	The aims of this course are: • to acquire and understand concepts and knowledge in optimizing and designing models of smart logistics systems (SLS), • correctly identify problems in this field and gain knowledge for the construction of models and the use of optimization methods and algorithms, • understand the working mechanisms of optimization methods and designed models and be able to use them correctly to solve problems, • acquire knowledge of the correct classification of various problems and use proper and appropriate optimization procedures and approaches to model design for a given problem, • to gain an understanding of the theoretical backgrounds necessary for the correct interpretation of the obtained optimization results and designed models and to assess the quality of the developed methods and models,

- pridobiti razumevanje fizikalnih in matematičnih mehanizmov v ozadju obravnavanih problemov in procesov v okviru PLS,
- se naučiti pravilno ovrednotiti ustreznost in kvaliteto načrtanih modelov in metod, ter znati pravilno uporabiti ustrezne metrike za testiranje veljavnosti modelov in metod,
- se naučiti pravilno interpretirati rezultate razvitih modelov in metod ter pravilno podati sklepe na osnovi načrtanih modelov in metod.

Kompetence, ki jih pridobijo študenti:
- osvojijo teoretično znanje na področju optimizacije in načrtovanja modelov PLS,
- poglobljeno razumejo področje optimizacije in načrtovanja modelov PLS,
- spoznajo in razumejo metrike pri optimizaciji in načrtovanju modelov PLS,
- razumejo fizikalne in matematične mehanizme v ozadju postopkov optimizacije in načrtovanja modelov PLS,
- rešujejo kompleksne probleme v logističnih sistemih s pomočjo optimizacije in načrtovanja modelov PLS,
- razumejo delovanje optimizacijskih metod in načrtanih modelov PLS, koristno tako v okviru tega, kot tudi drugih sorodnih predmetov.

- to gain an understanding of the physical and mathematical mechanisms behind the problems and processes addressed within the SLS,
- learn to properly evaluate the adequacy and quality of designed models and methods and adequately use appropriate metrics to test the validity of models and methods,
- learn to correctly interpret the results of developed models and methods and correctly draw conclusions based on designed models and methods.

Competences acquired by students:
- acquire theoretical knowledge in the field of optimization and design of models of SLS,
- have an in-depth understanding of the field of optimization and design of models of SLS,
- get to know and understand the metrics in the optimization and design of models of SLS,
- understand the physical and mathematical mechanisms behind the optimization and design of models of SLS,
- solve complex problems in logistics systems through the optimization and design of models of SLS,
- understand the working principles of optimization methods and designed models of SLS, useful both in this and other related subjects.

Predvideni študijski rezultati:

Znanje in razumevanje:
Študent/študentka bo ob zaključku predmeta zmožen:
- obvladati raziskovalne metode, postopke in procese na področju optimizacije in načrtovanja modelov PLS,
- samostojno znanstveno raziskovati na področju optimizacije in načrtovanja modelov PLS,
- razumeti uporabo optimizacije in načrtovanja modelov PLS in poglobljeno analizirati probleme s pomočjo sistemskega razmišljanja na tem področju,
- ustvarjalno sodelovati in reševati probleme v pametnih logističnih okoljih.
- pridobiti splošna in specifična znanja na področju optimizacije in načrtovanja modelov PLS,
- integrirati različne koncepte na področju optimizacije in načrtovanja modelov PLS, ki

Intended learning outcomes:

Knowledge and understanding:
The student will be able to:
- master research methods, procedures, and processes in the field of optimization and modeling design of SLS,
- able for independent scientific research work in the field of optimization and modeling design of SLS,
- understand the use of optimization methods and modeling design of SLS with the ability of in-depth problem analysis and systems thinking in this area,
- able to cooperate creatively in solving problems in smart logistics environments,
- acquire general and specific knowledge in the field of optimization and modeling design of SLS,
- develop the ability to integrate various concepts in the field of optimization and modeling design

vodijo k inovativnim rešitvam obravnavanih problemov,	of SLS, which lead to innovative solutions to the problems addressed,
• kritično analizirati kompleksna znanja, koncepte, pristope in strategije k optimizaciji in načrtovanju modelov,	• develop the ability to critically analyze complex knowledge, concepts, approaches, and strategies in optimizing and modeling of SLS,
• sintetizirati informacije s področja optimizacije in načrtovanja modelov PLS, ter prepoznati vrednosti znanja ali procesov z vidika predmeta in prakse.	• able to synthesize information in the field of optimization and modeling design of the SLS innovatively and recognize the value of knowledge or processes from the subject and practice perspective.
Študijski rezultati se bodo preverjali (in merili) na različne načine, kot je to definirano v deležih (v %) pri načinih ocenjevanja.	Study results will be checked (and measured) in different ways, as defined in shares (in%) in assessment methods.

Metode poučevanja in učenja:

Learning and teaching methods:

Predmet vključuje različne metode poučevanja in učenja, kot so: predavanja v klasični obliki, predavanja preko video predstavitev, filmov in webinarjev, predstavitve študentov in samostojni študij študentov.	The subject includes various teaching and learning methods, such as: lectures in classical form, lectures via video presentations, films and webinars, student presentations and independent student studies.
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 %) / 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	30%	• Written examination
• Ustni izpit	30%	• Oral examination
• Naloge pri e-predavanjih in e-vajah	10%	• E-lecture and e-tutorial tasks
• Raziskovalna naloga	30%	• Research task

Reference nosilca / Course coordinator's references:

IVANUŠA, Teodora, DRAGAN, Dejan, PODBREGAR, Iztok, HRIBAR, Gašper, ŽIROVNIK, Janez. *Intelligence and security challenges of the European migrant crisis : an insight into an innovative forecasting model*. *New

York: Nova Science Publishers, cop. 2018. X, 127 str., ilustr., graf. prikazi. European political, economic, and security issues. ISBN 978-1-53613-045-4 . [COBISS.SI-ID 7989779].

DRAGAN, Dejan, KRAMBERGER, Tomaž, POPOVIĆ, Vlado. Optimization methods and heuristics and their role in supply chains and logistics. V: VIDOVIĆ, Milorad (ur.). *Quantitative methods in logistics*. Belgrade: Faculty of Transport and Traffic Engineering, 2020. Str. 139-159, graf. prikazi, tabele. ISBN 978-86-7395-419-6 . http://doi.org/10.37528/FTTE/9786673954196.008 , DOI: 10.37528/FTTE/9786673954196.008. [COBISS.SI-ID 14364419].

Vlado Popović, Milorad Kilibarda, Milan Andrejić, Borut Jereb, Dejan Dragan. A New Sustainable Warehouse Management Approach for Workforce and Activities Scheduling. *MDPI Sustainability*. vol. 13, 2021. https://doi.org/10.3390/su13042021.

HAMMAD, Mahmoud A., JEREB, Borut, ROSI, Bojan, DRAGAN, Dejan. Methods and models for electric load forecasting : a comprehensive review. *Logistics & sustainable transport*. [Spletna izd.]. Feb. 2020, vol. 11, iss. 1, str. 51-76, ilustr. ISSN 2232-4968. https://doi.org/10.2478/jlst-2020-0004 , DOI: 10.2478/jlst-2020-0004. [COBISS.SI-ID 513089597].

DRAGAN, Dejan, KESHAVARZSALEH, Abolfazl, INTIHAR, Marko, POPOVIĆ, Vlado, KRAMBERGER, Tomaž. Throughput forecasting of different types of cargo in the Adriatic Seaport Koper. 2020. *Taylor-Francis Maritime policy & management*. [Spletna izd.]. ISSN 1464-5254. https://doi.org/10.1080/03088839.2020.1748242 , DOI: 10.1080/03088839.2020.1748242. [COBISS.SI-ID 513118781], [JCR, SNIP, WoS, Scopus].

VIZINGER, Tea, INTIHAR, Marko, JURIČIĆ, Đani, DRAGAN, Dejan. A scheduling algorithm for the optimal acquisition of biological material in the hospital logistics. *PTMF International Journal of Project and Technology Management*. Mar. 2020, vol. 2, iss.1,str. 58-77, ilustr. ISSN 2581-9887. http://www.ptmfonline.com/doc/A%20Scheduling%20Algorithm%20for%20the%20Optimal%20Acquisition%20of%20Biological%20Material%20in%20the%20Hospital%20Logistics.pdf. [COBISS.SI-ID 37372675].

DRAGAN, Dejan, KESHAVARZSALEH, Abolfazl, POPOVIĆ, Vlado, JEREB, Borut, INTIHAR, Marko. Heuristic-based optimisation approach : cost-effective school transportation. 2019. *Proceedings of the Institution of Civil Engineers - Transport*. [Print ed.]. vol. , iss. , str., ilustr., tabele. ISSN 0965-092X. https://www.icevirtuallibrary.com/doi/pdf/10.1680/jtran.18.00151 , DOI: 10.1680/jtran.18.00151. [COBISS.SI-ID 8120595], [JCR, SNIP].

INTIHAR, Marko, KRAMBERGER, Tomaž, DRAGAN, Dejan. Container throughput forecasting using dynamic factor analysis and ARIMAX model. *Promet*. [Print ed.]. 2017, vol. 29, no. 5, str. 529-542, ilustr. ISSN 0353-5320. [COBISS.SI-ID 512879421], [JCR, SNIP, WoS do 10. 8. 2020: št. citatov (TC): 6, čistih citatov (CI): 4, Scopus do 10. 8. 2020: št. citatov (TC): 5, čistih citatov (CI): 5].