UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Ime predmeta:	KVANTITATIVNE METODE IN MODELI V LOGISTIČNIH SISTEMIH
	QUANTITATIVE METHODS AND MODELS IN LOGISTIC SYSTEMS

Študijski program in stopnja **Study programme and cycle**	**Študijska smer** **Study option**	**Letnik** **Year of study**	**Semester** **Semester**
LOGISTIKA SISTEMOV 2. stopnja		1.	2
SYSTEM LOGISTICS 2nd degree		1.	2.

Vrsta predmeta (obvezni ali izbirni) / **Course type (compulsory or elective)**	OBVEZNI COMPULSORY
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**
45 a-P		10 e-V 30 a-V			155	8

Nosilec predmeta / Course coordinator:	**DEJAN DRAGAN**
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. Modeliranje stohastičnih procesov in čakalnih vrst: Izbrana poglavja iz teorije verjetnosti, Markovske verige, Markovski, Poissonovi, rojstno-smrtni procesi, Enokanalni in večkanalni sistemi množične strežbe tipa M/M/r.	1. Modeling of stochastic processes and queues: Selected texts from probability theory, Markov chains, Markov, Poisson, birth-death processes, single-channel and multi-channel queueing systems of the type M/M/r.
2. Teorija grafov in mrežna optimizacija: osnovne definicije, Eulerjevi in Hamiltonovi grafi, drevesa, različni algoritmi in metode za tipične probleme (kitajski poštar, trgovski potnik, minimalno vpeto drevo, maksimalen pretok, najkrajša pot, lokacijski problemi).	2. Graph theory and network optimization: basic definitions, Euler and Hamilton graphs, trees, Different algorithms and methods for typical problems (Chinese post-man, traveling salesman, minimum spanning tree, maximum flow, shortest path, location problems).
3. Matematično programiranje in nelinearna optimizacija: optimizacijski modeli, nelinearno programiranje, osnovne nelinearne direktne in gradientne metode brez omejitev (Hooke-Jeeves,	3. Mathematical programming and nonlinear optimization: optimization models, nonlinear programming, basic nonlinear direct and gradient methods without constraints (Hooke-Jeeves, Nelder-

Nelder-Mead simplex, Najstrmejši spust, Newton), geometrijsko programiranje. 4. Multivariantna statistika in modeliranje strukturnih enačb: lastnosti multivariantnih podatkov, PCA analiza glavnih komponent, faktorska analiza, strukturno modeliranje (structural equation modeling). 5. Osnovni principi metod za večkriterijsko odločanje: analitični hierarhični procesi (AHP), mehki AHP modeli, TOPSIS modeli, DEX modeli, skupinsko odločanje, drugi modeli.	Mead simplex, Steepest descent, Newton), geometric programming. 4. Multivariate statistics and structural equation modeling: properties of multivariate data, PCA analysis of principal components, factor analysis, structural equation modeling. 5. Basic principles of methods for multi-criteria decision-making: analytical hierarchical processes (AHP), fuzzy-AHP models, TOPSIS models, DEX models, group decision making, other models.

Cilji in kompetence:	Objectives and competences:
Cilji predmeta so: • osvojiti in razumeti pojme in znanja s področja kvantitativnih metod in modelov logističnih sistemov (LS). • pravilno identificirati probleme s tega področja in pridobiti znanja za konstrukcijo modelov in uporabo kvantitativnih metod v LS. • razumeti mehanizme delovanja kvantitativnih metod in modelov LS, ter jih znati pravilno uporabiti za reševanje problemov. • pridobiti znanja pravilne klasifikacije različnih problemov in zmožnosti uporabe pravilnih in ustreznih postopkov kvantitativnih metod in modelov LS za dani problem. • pridobiti razumevanje teoretičnih ozadij, nujno potrebnih za pravilno interpretacijo dobljenih rezultatov kvantitativnih metod in modelov LS in ocenitev njihove kakovosti. • pridobiti razumevanje fizikalnih in matematičnih mehanizmov v ozadju obravnavanih problemov in procesov v okviru logističnih sistemov. • se naučiti pravilno ovrednotiti ustreznost in kvaliteto načrtanih kvantitativnih metod in modelov LS, ter znati pravilno uporabiti ustrezne metrike za testiranje njihove veljavnosti. • se naučiti pravilno interpretirati rezultate razvitih kvantitativnih metod in modelov LS ter pravilno podati sklepe na njihovi osnovi.	The aims of this course are: • to acquire and understand concepts and knowledge in the field of quantitative methods and models of logistics systems (LS). • correctly identify problems in this field and gain knowledge for the construction of models and the use of quantitative methods in LS. • understand the working mechanisms of methods and models of LS and be able to use them correctly to solve problems. • acquire knowledge of the correct classification of various problems and use proper and appropriate procedures of quantitative methods and models of LS for a given problem. • to gain an understanding of the theoretical backgrounds necessary for the correct interpretation of the obtained results of quantitative methods and models of LS and to assess their quality. • to gain an understanding of the physical and mathematical mechanisms behind the problems and processes addressed within the logistics systems. • learn to properly evaluate the adequacy and quality of quantitative methods and models of LS and adequately use appropriate metrics to test their validity. • learn to correctly interpret the results of developed models and methods of LS and correctly draw conclusions based on designed models and applied methods.

Kompetence, ki jih pridobijo študenti:	Competences acquired by students:
• osvojijo teoretično znanje na področju kvantitativnih metod in modelov LS; • poglobljeno razumejo kvantitativne metode in modele LS; • spoznajo in razumejo metrike pri kvantitativnih metodah in modelih LS; • razumejo fizikalne in matematične mehanizme v ozadju kvantitativnih metod in modelov LS; • rešujejo kompleksne probleme v logističnih sistemih s pomočjo kvantitativnih metod in modelov LS. • razumejo delovanje kvantitativnih metod in modelov LS, koristno tako v okviru tega, kot tudi drugih sorodnih predmetov.	• acquire theoretical knowledge in the field of quantitative methods and models of LS; • have an in-depth understanding of quantitative methods and models of LS; • get to know and understand metrics in quantitative methods and models of LS; • understand the physical and mathematical mechanisms behind the quantitative methods and models of LS; • solve complex problems in logistics systems using quantitative methods and models of LS. • understand the working principles of quantitative methods and models of LS, useful both in this and other related subjects.

Predvideni študijski rezultati:	**Intended learning outcomes:**
Znanje in razumevanje: Študent bo ob zaključku predmeta zmožen: • obvladati raziskovalne metode, postopke in procese na področju kvantitativnih metod in modelov LS. • samostojno znanstveno raziskovati na področju kvantitativnih metod in modelov LS. • razumeti uporabo kvantitativnih metod in modelov LS • poglobljeno analizirati probleme s pomočjo sistemskega razmišljanja na tem področju. • integrirati različne koncepte kvantitativnih metod in modelov LS, ki vodijo k inovativnim rešitvam obravnavanih problemov. • kritično analizirati kompleksna znanja, koncepte, in pristope k uporabi kvantitativnih metod in načrtovanju kvantitativnih modelov, ter oblikovanju ustreznih strategij. • sintetizirati informacije s področja kvantitativnih metod in modelov LS, ter prepoznati vrednosti znanja ali procesov z vidika predmeta in prakse. Študijski rezultati se bodo preverjali (in merili) na različne načine, kot je to definirano v deležih (v %) pri načinih ocenjevanja.	Knowledge and understanding: The student will be able to: • Master research methods, procedures, and processes in the field of quantitative methods and models of LS. • Able for independent scientific research work in the field of quantitative methods and models of LS. • understand the use of quantitative methods and models of LS with the ability of in-depth problem analysis and systems thinking in this area. • Develop the ability to integrate various concepts in the field of quantitative methods and models of LS, which lead to innovative solutions to the problems addressed. • develop the ability to critically analyze complex knowledge, concepts, approaches, and strategies related to quantitative methods and models of logistics systems. • Able to synthesize information in the field of quantitative methods and models of LS innovatively and recognize the value of knowledge or processes from the subject and practice perspective.

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	The subject includes various teaching and learning methods, such as: lectures in classical form, lectures

webinarjev, predstavitve študentov in samostojni študij študentov. 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).	via video presentations, films and webinars, student presentations and independent student studies. 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 %) / 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].

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.

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]

KRAMAR, Uroš, DRAGAN, Dejan, TOPOLŠEK, Darja. The holistic approach to urban mobility planning with a modified focus group, SWOT, and fuzzy analytical hierarchical process. *MDPI Sustainability*. 2019, vol. 11, iss. 23, str. [1]-29, ilustr. ISSN 2071-1050. https://doi.org/10.3390/su11236599 ,

DOI: 10.3390/su11236599. [COBISS.SI-ID 513044029], [JCR, SNIP, WoS do 13. 9. 2020: št. citatov (TC): 2, čistih citatov (CI): 2, Scopus]

DRAGAN, Dejan, KESHAVARZSALEH, Abolfazl, JEREB, Borut, TOPOLŠEK, Darja. Integration with transport suppliers and efficiency of travel agencies. *Inderscience International journal of value chain management*. 2018, vol. 9, no. 2, str. 122-148, ilustr. ISSN 1741-5365. http://www.inderscience.com/info/ingeneral/forthcoming.php?jcode=ijvcm#70101, DOI: 10.1504/IJVCM.2018.10013594 . [COBISS.SI-ID 512918845], [SNIP]

TOPOLŠEK, Darja, DRAGAN, Dejan. Relationships between the motorcyclists' behavioural perception and their actual behaviour. . *Taylor-Francis Transport*. [Online ed.]. 2018, no. 1, vol. 33, str. 151-164. ISSN 1648-3480. https://journals.vgtu.lt/index.php/Transport/article/view/151, DOI: 10.3846/16484142.2016.1141371 . [COBISS.SI-ID 512755261], [JCR, SNIP, WoS do 13. 9. 2020: št. citatov (TC): 2, čistih citatov (CI): 2, Scopus do 10. 8. 2020: št. citatov (TC): 3, čistih citatov (CI): 2]

KOVAČIĆ, Nataša, TOPOLŠEK, Darja, DRAGAN, Dejan. Tourism sector, travel agencies, and transport suppliers : comparison of different estimators in the structural equation modeling. *Logistics & sustainable transport*. [Spletna izd.]. 2015, vol. 6, iss. 1, str. 11-24. ISSN 2232-4968. http://www.degruyter.com/view/j/jlst.2015.6.issue-1/jlst-2015-0007/jlst-2015-0007.xml?format=INT, DOI: 0.1515/jlst-2015-0007. [COBISS.SI-ID 512729661]

TOPOLŠEK, Darja, DRAGAN, Dejan. Behavioural comparison of driverswhen driving a motorcycle or a car : a structural equation modelling study. *Promet*. [Print ed.]. 2015, vol. 27, no. 6, str. 457-466, ilustr. ISSN 0353-5320. http://www.fpz.unizg.hr/traffic/index.php/PROMTT/issue/view/163. [COBISS.SI-ID 512739133], [JCR, SNIP, WoS do 10. 8. 2020: št. citatov (TC): 3, čistih citatov (CI): 2, Scopus do 28. 8. 2020: št. citatov (TC): 3, čistih citatov (CI): 2]