

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Osnove modeliranja in simulacije dogodkovnih in zveznih sistemov
Course title:	Fundamentals of Modelling and Simulation of Discrete and Continuous Systems

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Računalništvo in spletne tehnologije, magistrski študijski program druge stopnje	-	Prvi	Drugi
Computer Science and Web Technologies, second cycle Masters Study Programme	-	First	Second

Vrsta predmeta / Course type

Izbirni / Elective

Univerzitetna koda predmeta / University course code:

2-RST-MAG-IP-OMSDZS-2019-03-12

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	-	45	-	-	75	5

Nosilec predmeta / Lecturer:

izr. prof. dr. Blaž Rodič

Jeziki / Languages:**Predavanja / Lectures:** slovenski, angleški / Slovene, English**Vaje / Tutorial:** slovenski, angleški / Slovene, English**Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**

Študent/študentka mora pred pristopom k izpitu imeti pozitivno ocenjene vaje in seminarsko nalogo.

Prerequisites:

Positively evaluated exercises and seminar paper are a prerequisites for exam.

Vsebina:

- *Uvod v predmet.*
Namen študija predmeta, povezanost predmeta z drugimi predmeti, vsebina študija predmeta, študijska literatura. Simulacija sistemov in reševanje poslovnih in organizacijskih problemov.
- *Diskretna dogodkovno orientirana simulacija.*
Stohastične spremenljivke in verjetnostna funkcija.

Content (Syllabus outline):

- *Introduction to the course.*
The purpose of the study object, integration with other subjects, study the course content, textbooks. Simulation systems and solving business and organizational problems.
- *Discrete event-oriented simulation*
Stochastic variables and probability function.
Probability distribution and generatig

<p>Verjetnostne porazdelitve in generiranje slučajne spremenljivke. Enakomerna, eksponentna in empirična porazdelitev. Modeli strežbe. Porazdelitve časov med prihodi in časov strežbe. Disciplina vrste. Generiranje časov med prihodi in časov strežbe.</p> <ul style="list-style-type: none"> • <i>Zvezna simulacija in sistemska dinamika.</i> Diferenčne in diferencialne enačbe v simulaciji. Vzročno posledični diagrami in referenčni odziv sistema. Oblikovanje dinamične hipoteze. Razvoj modelov sistemske dinamike. Zbiranje podatkov, izračun statistike in analiza rezultatov. • <i>Testiranje in validacija modelov.</i> • <i>Načrtovanje eksperimentov.</i> • <i>Pregled simulacijskih jezikov: GPSS, AnyLogic.</i> • <i>Simulacijski primeri:</i> Kreativno Jedro: Simulacije in drugi projekti. • <i>Modeliranje kompleksnih sistemov:</i> • <i>Metode iz projekta Kreativno Jedro: Simulacije.</i> 	<p>random variables. Uniform, exponential and empirical distribution. Service models. Distribution of time between arrivals and times of comfort and convenience. Queue discipline. Generating times between arrivals and times of comfort and convenience.</p> <ul style="list-style-type: none"> • <i>Continuous simulation and system dynamics.</i> Difference and differential equations in simulation. Cause and effect diagram and reference system response. Creating a dynamic hypothesis. Development of system dynamics models. Data collection, calculation and statistical analysis results. • <i>Testing and validation of models.</i> • <i>Design of Experiments.</i> • <i>Review of simulation languages: GPSS, AnyLogic.</i> • <i>Simulation examples: Creative Core: Simulations and other projects.</i> • <i>Modelling complex systems.</i> • <i>Automated model building (methods developed in Creative Core: Simulations).</i>
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Temeljni literatura in viri / Readings:

- Banks, J., Carson, J. S., Nelson, B. L., Nicol, D. M. (2009) Discrete-Event System Simulation, Prentice Hall.
- Borschchev A. (2013) The Big Book of Simulation Modeling. Multimethod Modeling with AnyLogic 6, AnyLogic North America.
- Grigoryev, I., Borschchev A. (2012) AnyLogic 6 in Three Days: A Quick Course in Simulation Modeling.
- Sterman, J. D. (2000) Business Dynamics: Systems Thinking and Modeling for a Complex World, Irwin/McGraw-Hill.
- Law, A., Kelton, W. D. (1999) Simulation Modeling and Analysis. McGraw-Hill.
- Severance, F. L. (2001) System Modeling and Simulation: An Introduction, John Wiley & Sons, Chichester.
- Kljajić M. (1994) Teorija sistemov, Fakulteta za organizacijske vede.

Cilji in kompetence:

Cilji:

- seznaniti slušatelje s področjem uporabe dogodkovne simulacije in sistemske dinamike pri reševanju organizacijskih problemov
- spoznati metode in tehnike modeliranja po principih dogodkovne simulacije in sistemske dinamike
- obvladati kvantitativni pristop k izgradnji dogodkovnih modelov in modelov sistemske dinamike
- obravnavati osnove simulacijskih jezikov
- osvojiti postopke priprave eksperimenta in interpretacijo rezultatov
- izvedba celovitega projekta s področja dogodkovne simulacije in sistemske dinamike na akademskem primeru

Učna enota prispeva k razvoju naslednjih splošnih in predmetno specifičnih kompetenc:

- sposobnost algoritmičnega razmišljanja;
- sposobnost obvladovanja in pretvorbe realnega problema v obliki lažje predstavljivega modela;
- poznavanje pomena kakovosti in prizadevanje za kakovost strokovnega dela skozi avtonomnost, samoiniciativnost, (samo)kritičnost, (samo)refleksivnost in (samo)evalviranje v strokovnem delu;
- zmožnost za prepoznavanje in izkoriščanje priložnosti, ki jih ponuja spletna tehnologija;
- usposobljenost za samostojno in avtonomno uporabo, nadzor in vzdrževanje informacijsko komunikacijske tehnologije v organizaciji;
- obvladovanje sodobnih visokozmogljivih orodij in specifične programske opreme za delo z njimi;
- poglobljeno razumevanje in kritično razmišljanje o zmožnostih in omejitvah informacijsko komunikacijskih tehnologij;
- poznavanje programskih orodij in metodologij za analizo podatkov ter

Objectives and competences:

Objectives:

- the main objective of the course is to introduce the application of discrete simulation and system dynamics at solving of the organizational problems
- understand the methods and techniques of modeling by the principles of discrete event simulation and system dynamics
- learn the quantitative approach to the discrete event models building and system dynamics models
- learn the basics of simulation languages
- study the experimental design approaches and interpretation of the results
- conduct of the complete project in the field of discrete event simulation and system dynamics in an academic case

The instructional unit contributes to the development of the following general and subject-specific competences:

- ability of algorithmic thinking;
- ability to manage and transform a real-life problem into the form of an easier to perceive model.
- familiarity with the importance of quality, striving to maintain the quality of professional work through practicing autonomous behaviour, showing initiative, as well as through (self-)criticism, (self-)reflection and (self-)evaluation;
- ability to recognize and seize opportunities offered by the web technology;
- competence for independent and autonomous use, monitoring and maintenance of information communication technology in an institution;
- management of modern high-performance tools and specific software for working with them;
- in-depth understanding and critical thinking regarding the possibilities and

simulacije diskretnih oziroma zveznih modelov;

- sposobnost analize stanja na področju informatizacije organizacije in izdelave predlogov za izboljšanje stanja.

limitations of information and communication technologies;

- knowledge of programming tools and methodologies for data analysis and simulation of discrete and continuous models;
- competence to analyse the state in the field of informatisation of an organisation and generate suggestions for the improvement of said state.

Predvideni študijski rezultati:

Znanje in razumevanje:

Študent/študentka pridobi znanja za:

- kvantitativno modeliranje organizacijskih problemov na področju proizvodnje, logistike in sistemov strežbe
- analizo vhodnih podatkov, priprava in statistična obdelava
- definicijo kriterijev in dinamično testiranje hipoteze pri izboru rešitve
- optimizacija procesov z uporabo simulacijskih orodij

Intended learning outcomes:

Knowledge and understanding:

The student has the knowledge of:

- quantitative modeling of organizational problems in manufacturing, logistics, and service systems
- input data analysis, preparation and statistical processing
- definition of criterions and dynamical hypothesis testing at the solution selection
- process optimization using simulation tools

Metode poučevanja in učenja:

- *predavanja* z aktivno udeležbo študentov (razlaga, diskusija, vprašanja, primeri, reševanje problemov)
- *laboratorijske vaje* (uporaba simulacijskih orodij)
- individualne in skupinske *konzultacije* (diskusija, dodatna razlaga, obravnava specifičnih vprašanj)

Learning and teaching methods:

- *lectures* with active students' involvement (explanation, discussion, questions, examples, problem solving)
- *laboratory work* (usage of simulation tools)
- individual and group *consultations* (discussions, supplementary explanations, treatment of specific questions)

Delež (v %) /

Weight (in %)

Načini ocenjevanja:

Assessment:

<p>Način (pisni izpit, ustno izpraševanje, naloge, projekt):</p> <ul style="list-style-type: none"> • pisni izpit • empirična seminarska naloga, poročila laboratorijskih vaj 	<p>50 % 50 %</p>	<p>Type (examination, oral, coursework, project):</p> <ul style="list-style-type: none"> • written exam • empirical seminar work, report on laboratory exercises
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Reference nosilca / Lecturer's references:

- RODIČ, Blaž. Industry 4.0 and the new simulation modelling paradigm. Organizacija : revija za management, informatiko in kadre, ISSN 1318-5454. [Tiskana izd.], aug. 2017, vol. 50, no. 3, str. 193-207, ilustr., doi: 10.1515/orga-2017-0017
- BRELIH, Marjan, RAJKOVIČ, Uroš, RUŽIČ, Tomaž, RODIČ, Blaž, KOZELJ, Daniel. Modelling decision knowledge for the evaluation of water management investment projects. Central European Journal of Operations Research, ISSN 1435-246X, 2018, vol. , iss. , str. <https://link.springer.com/content/pdf/10.1007%2Fs10100-018-0600-5.pdf>, doi: 10.1007/s10100-018-0600-5.
- KANDUČ, Tadej, RODIČ, Blaž. Optimisation of machine layout using a force generated graph algorithm and simulated annealing. International journal of simulation modelling, ISSN 1726-4529, 2016, vol. 15, no. 2, str. 275-287.
- RODIČ, Blaž, BAGGIA, Alenka. Dynamic airport ground crew scheduling using a heuristic scheduling algorithm. International journal of applied mathematics and informatics, ISSN 2074-1278, 2013, vol. 7, iss. 4, str. 153-163.
- RODIČ, Blaž. Mobile agents for distributed decision support systems. The International Scientific Journal of Management Information Systems, ISSN 1452-774X, 2011, vol. 6, no. 1, str. 20-27.
- RODIČ, Blaž, KLJAJIĆ, Miroljub. Accessing distributed data sources with mobile agents and XML. V: JAŠKOVÁ, Mária (ur.). ECON '05 : [selected research papers], (Research works proceedings, ISSN 0862-7908, Vol. 12, 2005). Ostrava: Technical University of Ostrava, Faculty of Economics. 2005, str. 280-287.
- RODIČ, Blaž, KLJAJIĆ, Miroljub. Integracija simulacijskih orodij v e-poslovni informacijski sistem. V: GRIČAR, Jože (ur.). Izboljšanje konkurenčnosti regije z e-poslovanjem, (Organizacija, ISSN 1318-5454, Letn. 37, 2004, št. 3). Kranj: Moderna organizacija. 2004, str. 162-167.
- ŠKRABA, Andrej, BAGGIA, Alenka, RODIČ, Blaž. Application of a group decision support system in the reform of study programmes. V: DONDON, Philippe (ur.). Recent advances in education and modern educational technologies, (Educational technologies series, 9). [S. l.: s. n.]. 2013, str. 128-134.
- RODIČ, Blaž. Issues of e-collaboration and knowledge management in media industries. V: LUGMAYR, Artur (ur.), et al. Information systems and management in media and entertainment industries, (International series on computer entertainment and media technology (Online), ISSN 2364-9488). Cham: Springer. cop. 2016.