

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Uvod v modeliranje in simulacijo dogodkovnih in zveznih sistemov
Course title:	Introduction to 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, visokošolski strokovni študijski program prve stopnje	-	Drugi ali tretji	Četrty ali šesti
Computer Science and Web Technologies, first cycle Professional Study Programme	-	Second or third	Fourth or sixth

Vrsta predmeta / Course type

Izbirni / Elective

Univerzitetna koda predmeta / University course code:

2-RST-VS-IP-UMSDZS-2020-05-14

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
30	-	45	-	-	105	6

Nosilec predmeta / Lecturer:

izr. prof. dr. Blaž Rodič

Jeziki / Languages:

Predavanja / Lectures: Slovenski / Slovenian, Angleški / English

Vaje / Tutorial: Slovenski / Slovenian, Angleški / English

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:

Študent/študentka mora pred pristopom k izpitu pripraviti in zagovarjati empirično seminarsko nalogo.

Prerequisites:

The student is obliged to prepare and defend their seminar paper before the admission to the examination.

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.

<p>Verjetnostne porazdelitve in generiranje slučajne spremenljivke. Modeli 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. Razvoj modelov sistemske dinamike. Zbiranje podatkov, izračun statistike in analiza rezultatov. • <i>Agentna simulacija</i> Vrste agentov. Primeri agentnih modelov. • <i>Uvod v projekt, Izbira teme projekta</i> • <i>Testiranje in validacija modelov</i> • <i>Načrtovanje eksperimentov</i> • <i>Simulacijski primeri:</i> Kreativno Jedro: Simulacije in drugi projekti. • <i>Modeliranje kompleksnih sistemov:</i> Metode iz projekta Kreativno Jedro: Simulacije. 	<p>Probability distribution and generating random variables. Service models.</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. Development of system dynamics models Data collection, calculation and statistical analysis results. • <i>Agent based simulation</i> Agent types. Agent based model examples. • <i>Introduction to the project, choice of theme for the project</i> • <i>Testing and validation of models</i> • <i>Design of Experiments</i> • <i>Simulation examples:</i> Creative Core: Simulations and other projects. • <i>Modelling complex systems</i> Automated model building (methods developed in Creative Core: Simulations).
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Temeljni literatura in viri / Readings:

<ul style="list-style-type: none"> • Banks, J., Carson, J. S., Nelson, B. L. & Nicol, D. M. (2009). <i>Discrete-Event System Simulation</i> (5th ed.). Prentice Hall. • Borschchev A. (2013). <i>The Big Book of Simulation Modeling. Multimethod Modeling with AnyLogic 6</i>. AnyLogic North America. • Sterman, J. D. (2000). <i>Business Dynamics: Systems Thinking and Modeling for a Complex World</i>. Irwin/McGraw-Hill. • Law, A. (2014). <i>Simulation Modeling and Analysis</i> (5th ed.). McGraw-Hill. • Kljajić, M. (1994). <i>Teorija sistemov</i>. Kranj: Moderna organizacija. • Atanasijević-Kunc, M., Karba, R. & Zupančič, B. (2016). <i>Modeliranje in simulacija</i>. Založba FE.

Cilji in kompetence:

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| <p>Cilji:</p> <ul style="list-style-type: none"> • 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 |
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Objectives and competences:

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| <p>Objectives:</p> <ul style="list-style-type: none"> • 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 |
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- 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:

Splošne kompetence:

- poznavanje pomena kakovosti in prizadevanje za kakovost strokovnega dela skozi avtonomnost, samoiniciativnost, (samo)kritičnost, (samo)refleksivnost in (samo)evalviranje v strokovnem delu
- prepoznavanje in ocenitev aktualnih in nastajajočih tehnologij ter ocenitev njihove uporabnosti za reševanje potreb uporabnikov
- usposobljenost za samoučenje s ciljem obvladovanja najnovejših relevantnih spletnih in mobilnih tehnologij
- sposobnost varnega in namenskega koriščenja najzahtevnejših spletnih storitev
- zmožnost za prepoznavanje in izkoriščanje priložnosti, ki jih ponuja spletna tehnologija

Predmetnospecifične kompetence:

- poznavanje in obvladanje simulacijskih metod in orodij, v domeni zveznih kakor tudi dogodkovnih modelov
- celovito načrtovanje in obvladovanje dogodkovnih in zveznih procesov
- izgradnja dogodkovnih simulacijskih modelov
- izgradnja modelov sistemske dinamike
- povezovanje simulacijskih modelov s podatkovnimi bazami in produkcijskimi informacijskimi sistemi
- harmonizacija delovnih procesov
- odprava ozkih grl v delovnih procesih
- analiza strukture in odziva sistema s pomočjo sistemske dinamike

- 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:

General competences:

- 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
- identification and evaluation of current and emerging technologies, and assessment of their usability in terms of fulfilling user requirements
- ability to self-educate with the aim to master relevant state-of-the-art web and mobile technologies
- ability to safely and purposefully use the most complex web services
- Ability to recognize and seize opportunities offered by the web technology

Subject-specific competences:

- knowledge and ability to use simulation methods and tools, both discrete and continuous
- complete design and control of discrete and continuous processes
- building of discrete event simulation models
- building of system dynamics models
- connection of the simulation models with databases and production information systems
- harmonization of production processes
- elimination of bottle-necks in production processes

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- analysis of structure and response of the system by the aid of system dynamics

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 criteria 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 %) **Assessment:**

Načini ocenjevanja:

Način (pisni izpit, ustno izpraševanje, naloge, projekt):		Type (examination, oral, coursework, project):
<ul style="list-style-type: none"> • pisni izpit • empirična seminarska naloga s poročili eksperimentalnih vaj ter predstavitev naloge 	<p>50</p> <p>50</p>	<ul style="list-style-type: none"> • written examination • empirical student assignment with the reports from experimental exercises together with the presentation of the assignment

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, Mirosljub. 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, Mirosljub. 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.