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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Metode modeliranja | | | | | | | | | | | | | | |
| **Course title:** | | | Modelling Methods | | | | | | | | | | | | | | |
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| **Študijski program in stopnja**  **Study programme and level** | | | | | **Študijska smer**  **Study field** | | | | | | | | **Letnik**  **Academic year** | | **Semester**  **Semester** | | |
| Podiplomski magistrski študijski program druge stopnje Elektrotehnika | | | | | Avtomatika in informatika | | | | | | | | 1 | | 1 | | |
| 2nd cycle masters study programme in Electrical Engineering | | | | | Control systems and computer engineering | | | | | | | | 1 | | 1 | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Obvezni-strokovni / Compulsory professional | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64204 | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| **45** | **0** | | | **30** | | |  | | | |  | | | **75** | |  | **6** |
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| **Nosilec predmeta / Lecturer:** | | | | | Maja Atanasijević-Kunc | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | slovenski, v primeru večjega števila tujih študentov angleški / Slovene, in case of a large number of foreign students English | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | slovenski, v primeru večjega števila tujih študentov angleški / Slovene, in case of a large number of foreign students English | | | | | | | | | | | |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | | | | | | | | |  | **Prerequisits:** | | | | | | | |
| Vpis v letnik. | | | | | | | | |  | Enrolment in the year of the course. | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| Uvod (razlogi za gradnjo modelov, osnovne definicije, pristopi k modeliranju)  Vpeljava podobnosti, oz. analogij in njihov pomen v kontekstu sistemskega inženirstva  Ilustracija pomena modeliranja s primeri s področja elektrotehnike, mehanike, hidravlike in pnevmatike, termodinamike, ekonomije, medicine, farmacije in biologije ter vodenja  Analiza in poenostavljanje modelov (strukturno poenostavljanje in linearizacija)  Posebne vrste modelov (prostorni modeli, bond grafi, hibridni modeli, nekatere povezave z UI pristopi)  Intuitivno jasni pristopi: metode prilagajanja odziva, ideje odkrivanja napak na osnovi modela  Optimizacija modelov s klasičnimi pristopi in metodami evolucijskega računanja  Raba že poznanih programskih orodij (Matlab, Simulink, Control System Toolbox) in predstavitev nekaterih dodatnih možnosti v Matlabu in v nekaterih drugih okoljih, primernih tudi za obravnavo sistemske dinamike in za učinkovito vizualizacijo  Ilustrativni primeri načrtovanja modelov ob uporabi kompleksnejših laboratorijskih pilotnih naprav. | | | | | | | |  | | Introduction (the reasons for the construction of models, basic definitions, approaches of model design)  Introduction of similarities or analogies and their importance in the context of systems’ engineering  Illustration of the importance of modelling with examples from the field of electrical engineering, mechanics, hydraulics, and pneumatics, thermodynamics, economics , medicine, pharmacy and biology, system control  Analysis and model simplification (structural simplification and linearization)  Specific types of models (compartment models, bond graphs, hybrid models, some of AI approaches)  Intuitively clear approaches: response adaptation methods, model based fault detection  Conventional approaches of models‘ optimization and usage of evolutionary computation  Usage of already known software tools (Matlab, Simulink, Control System Toolbox) and the presentation of some additional toolboxes in Matlab and in some other programs, suitable for the so called system dynamics and visualization.  Illustrative examples of model design of complex laboratory pilot plants. | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. ATANASIJEVIĆ-KUNC, Maja. Metode modeliranja, Študijsko gradivo. Fakulteta za elektrotehniko, Univerza v Ljubljani, 2016. 2. KARBA, Rihard, Modeliranje procesov, Fakulteta za elektrotehniko, Založba FE in FRI, Univerza v Ljubljani, 1999. 3. ATANASIJEVIĆ-KUNC, Maja. Modeliranje procesov: Zbirka primerov z ilustracijami v okolju Matlab-Simulink. Fakulteta za elektrotehniko, Založba FE in FRI, 2008. 4. CELLIER, François, E.. Continuous system modeling, Springer-Verlag, New York, 1991. 5. GODFREY, Keith. Compartmental Models and Their Application. Academic Press, London, 1983. 6. FOGEL, D.B.. Evolutionary Computation, Toward a New Philosophy of Machine Intelligence, IEEE Press Series on Computational Intelligence, 2006. 7. MAGRAB, Edward B., AZRAM, Shapour, BALACHANDRAN, Balakumar, DUNCAN, James H., HEROLD, Keith E., WALSH, Gregory C.. An Engineer's Guide to MATLAB with Applications from Mechanical, Aerospace, Electrical, and Civil Engineering. Pearson Prentice Hall, New Jersey, 2005. 8. MONSEF Youssef. Modelling and simulation of complex systems, concepts, methods and tools. Erlangen: Society for Computer Simulation Int.; 1997. | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| predstaviti zahtevnejša znanja s področja modeliranja procesov,  opozoriti na razširjenost oz. multidisciplinarnost področja in s tem na njegov širok pomen,  predstaviti značilne in tudi nekatere posebne oblike modelov in področja njihove uporabe,  predstaviti nekatera programska orodja in njihovo uporabnost v podporo obravnavani tematiki,  študente seznaniti z načrtovanjem eksperimentov in njihovim izvajanjem v podporo teoretičnim načinom modeliranja,  predstaviti uporabo verifikacije in vrednostenja pri gradnji modelov realnih sistemov,  študente seznaniti z metodami iskanja primerne literature, raziskovanja in ustrezne pisne in ustne predstavitve rezultatov dela. | |  | | to present advanced knowledge in the field of process modelling,  to accent the wide and multidisciplinary nature of the area and thus its broad meaning,  to present typical and also some specific forms of models and their scope,  to present some of the software tools and their usefulness in support of the issue being discussed,  to acquaint students with the experiments design and their implementation in support to theoretical modelling approach,  to present verification and evaluation in modelling of real systems,  to acquaint students with appropriate literature search, research work, and appropriate written and oral presentation of work results. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Študentje bodo pridobili znanja, ki bodo omogočala:  -sistemski pristop k reševanju problemov modeliranja (teoretično, eksperimentalno in kombinirano);  -določanje lastnosti dinamičnih matematičnih modelov;  -analitično in simulacijsko eksperimentiranje z linearnimi in nelinearnimi modeli ter izvajanje medsebojne primerjave;  -optimiranje matematičnih modelov s klasičnimi metodami in evolucijskimi algoritmi;  -kvalitativno in kvantitativno vrednotenje modelov;  -uporabo teoretičnih pristopov pri modeliranju realnih sistemov. | | |  | Gained knowledge will enable:  -a systematic approach to problem solving by modelling (theoretical , experimental and combined);  -properties’ determination of dynamic mathematical models;  - analytical and simulation experimentation using linear and non-linear models and the implementation of mutual comparison;  -optimization of mathematical models using conventional methods and evolutionary algorithms;  -qualitative and quantitative evaluation of developed models;  -the use of theoretical approaches in modelling real systems. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja, laboratorijske vaje, domače naloge, seminarske in projektne naloge | | |  | Lectures, laboratory exercises, homeworks, seminar and project work | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Način: laboratorijske vaje, seminarska/projektna naloga, ustni izpit  Ocene od 1 do vključno 5 so negativne, ocene od vključno 6 do 10 so pozitivne.  Pozitivna ocena laboratorijskih vaj je pogoj za pristop k izpitu.  Prispevki k oceni:   * laboratorijske vaje * seminarska/projektna naloga * ustni izpit | 10%  30%  60% | | | | Type: laboratory exercises, seminar/project work, oral exam  Negative grades: from 1 to 5, positive grades: from 6 to 10.  Positive evaluation of laboratory exercises is a prerequisite for the exam application.  Contributions to final grade:   * laboratory exercises * seminar/project work * oral exam |
| **Reference nosilca / Lecturer's references:** | | | | | |
| 1. SENTOČNIK, Jožica Tina, ATANASIJEVIĆ-KUNC, Maja, DRINOVEC, Jože, PFEIFER, Marija. Efficacy analysis of a body-mass-reduction treatment using mathematical modelling. Mathematical and computer modelling of dynamical systems, 2014, vol. 20, no. 2, str. 146-169. 2. ATANASIJEVIĆ-KUNC, Maja, DRINOVEC, Jože, GUŠTIN, Barbara, MRHAR, Aleš. Simulation analysis of economic burden in hypertension and myocardial infarction treatment with beta blockers = Simulacijsko vrednotenje ekonomskega bremena zdravljenja hipertenzije in miokardnega infarkta z uporabo beta blokatorjev. Zdravniški vestnik, 2012, letn. 81, št. 2, str. 105-118. 3. ATANASIJEVIĆ-KUNC, Maja, DRINOVEC, Jože, RUČIGAJ, Simona, MRHAR, Aleš. Simulation analysis of coronary heart disease, congestive heart failure and end-stage renal disease economic burden. Mathematics and computers in simulation, 2011, vol. 82, no. 3, str. 494-507. 4. ATANASIJEVIĆ-KUNC, Maja, LOGAR, Vito, KARBA, Rihard, PAPIĆ, Marko, KOS, Andrej. Remote multivariable control design using a competition game. IEEE transactions on education, 2011, vol. 54, no. 1, str. 97-103. 5. ATANASIJEVIĆ-KUNC, Maja, DRINOVEC, Jože, MRHAR, Aleš. Modeliranje in simulacija ter njuna uporaba v medicini in farmaciji = Usage of modelling and simulation in medicine and pharmacy. Zdravniški vestnik, 2008, letn. 77, št. 1, str. 57-71. | | | | | |