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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Napredne metode vodenja procesov | | | | | | | | | | | | | | |
| **Course title:** | | | Advanced Control Design 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 | | | | | Vse smeri | | | | | | | | 2 | | 1 | | |
| 2nd cycle masters study programme in Electrical Engineering | | | | | All study fields | | | | | | | | 2 | | 1 | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Izbirni-splošni /elective general | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64305 | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| 45 |  | | | 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 predmeta | | | | | | | | |  | Enrolment in the year of the course | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| Uvod, definicije pomembnejših pojmov, identifikacija potreb po razširitvi pristopov načrtovanja  Veliki sistemi, multivariabilni sistemi, fazno-neminimalni sistemi, sistemi z mrtvim časom, nelinearni sistemi, težko vodljivi sistemi  Predstavitve in analiza kompleksnih sistemov v časovnem in frekvenčnem prostoru s poudarkom na paralelizmih in razlikah h klasičnim predstavitvam  Kriteriji kvalitete načrtovanja v časovnem in frekvenčnem prostoru in koncepti optimalnosti (klasični pristopi in težave pri kompleksnih sistemih, ki se odražajo v problemih pri definiciji kriterijskih funkcij in konvergentnosti klasičnih metod, uporaba evolucijskega računanja in nekatere relativne prednosti)  Vpeljava pristopov načrtovanja, ki slonijo na direktnih razširitvah klasičnih metod (decentralizirano in hierarhično vodenje, uglaševanje regulatorjev, razstavljanje, INA, IMC, metode premikanja polov, ki slonijo na diadičnih regulatorjih)  Adaptivni regulatorji in nekateri pristopi k načrtovanju  Uporaba metod evolucijskega računanja pri načrtovanju kompleksnih sistemov z nekaterimi poudarki na učinkoviti kombinaciji predstavljenihalgoritmov  Koncepti ekspertnih sistemov pri načrtovanju vodenja  Raba programskega paketa Matlab z ustreznimi orodji  Ilustrativni primeri načrtovanja vodenja realnih sistemov ob uporabi kompleksnejših laboratorijskih pilotnih naprav. | | | | | | | |  | | Introduction, definitions of important concepts, identification of the needs for the extension of control design approaches  Large-scale systems, multivariable systems, phase-nonminimal systems, systems with a dead time, nonlinear systems, difficult-controlable systems  Presentation and analysis of complex systems in time and frequency domain, with emphasis on parallelisms and differences to the conventional presentations  Control design quality criteria in time and frequency domain and concepts of optimality (classical approaches and problems in complex systems which are reflected in the corresponding definition of fitness function and convergence of classical methods, the usage of evolutionary computation and some relative advantages )  Introduction of control design approaches that rely on direct extensions of classical methods (hierarchical and decentralized control, tuning, decoupling, INA , IMC , pole placement using dyadic contoller structures)  Adaptive controllers and some of design approaches  Usage of evolutionary computation methods in the design of complex systems with emphasis on the effective combination of the presented algorithms  Concepts of expert systems in control design  Usage of program Matlab with corresponding Toolboxes  Illustrative examples of control design of complex laboratory pilot plants. | | | | | | | |

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| **Temeljna literatura in viri / Readings:** | | | | | |
| 1. ATANASIJEVIĆ-KUNC, Maja. Napredne metode vodenja sistemov, Študijsko gradivo. Fakulteta za elektrotehniko, Univerza v Ljubljani, 2016. 2. KARBA, Rihard, ATANASIJEVIĆ-KUNC, Maja*.* Multivariabilni sistemi. Fakulteta za elektrotehniko, Univerza v Ljubljani, Založba FE in FRI, 2010. 3. ATANASIJEVIĆ-KUNC, Maja. Multivariabilni sistemi: Zbirka kompleksnejših problemov. Fakulteta za elektrotehniko, Univerza v Ljubljani, Založba FE in FRI, 2004. 4. ATANASIJEVIĆ-KUNC, Maja. Multivariabilni sistemi: Predstavitev, analiza in načrtovanje skozi primere. Fakulteta za elektrotehniko, Založba FE in FRI, 2003. 5. SKOGESTAD, Sigurd. POSTLETHWAITE, Ian. Multivariable Feedback Control, Analysis and Design, John Wiley and Sons, Chichester, 1996. 6. MORARI, M., and ZAFIRIOU, E.. Robust Process Control, Prentice-Hall, 1989. 7. JAMSHIDI, M.. Large-Scale Systems: Modeling, Control and Fuzzy Logic, Prentice Hall PRT, New Jersey, 1997. 8. LYSHEVSKI, S. E.. Control Systems Theory with Engineering Applications, Birkhauser, Boston, 2001. 9. ÅSTRÖM, Karl Johan, WITTENMARK, Björn. Adaptive control, Addison-Wesley Longman Publishing Co., Boston, MA, USA, 1994. 10. ÅSTRÖM, Karl Johan, HÄGGLUND, Tore. Advanced PID Control. With. ISA, 2005. 11. TEWARI, A.. Modern Control Design with Matlab and Simulink, John Wiley & Sons Ltd, Chichester, 2002. | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| razvrstiti sisteme vodenja, ki jih uvrščamo med kompleksne,  opisati metode analize, ki pojasnjujejo pomembne lastnosti tovrstnih sistemov,  pojasniti paralelizme in potrebne razširitve glede na klasične pristope vodenja,  predstaviti nekatere učinkovite pristope načrtovanja s poudarkom na različnih aspektih optimalnosti,  predstaviti nekatera programska orodja Matlaba in njihovo uporabnost v podporo obravnavani tematiki,  študente seznaniti z metodami iskanja primerne literature, raziskovanja in ustrezne pisne in ustne predstavitve rezultatov dela. | |  | | -to classify complex controlled systems,  to describe analytical methods which explain important properties of such systems,  to present parallelisms and necessary extensions in relation to classical control design approaches,  to present some of efficiant control design approaches with emphasis on different aspects of optimality,  to present some of Matlab toolboxes and their usefulness in support of the issues being discussed,  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:  -prepoznavanje sistemov, ki so kompleksni in težavni za vodenje;  -uporabo izbranih metod načrtovanja vodenja tovrstnih sistemov;  -njihovo izvedbo v obliki ekspernega sistema;  -implementacijo regulatorjev pri izvedbi vodenja realnih kompleksnih sistemov;  -kvantitativno in kvalitativno vrednotenje načtanega vodenja. | | |  | Gained knowledge will enable:  -systems' recognition that are complex and difficult to control;  - the use of selected control algorithms which are suitable for such systems;  -their implementation in the form of expert system;  -controllers’ implementation in closed-loop operation of real complex systems;  -quantitative and qualitative evaluation of closed-loop system design. | |
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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. 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 2. ATANASIJEVIĆ-KUNC, Maja, KARBA, Rihard, LOGAR, Vito. The role of internet-accessible laboratory plants in the teaching of automatic control. AZAD, Abul K. M. (ur.), AUER, Michael E. (ur.), HARWARD, V. Judson (ur.). Internet accessible remote laboratories : scalable E-learning tools for engineering and science disciplines, IGI Global: Engineering Science Reference, 2012, str. 144-162. 3. ATANASIJEVIĆ-KUNC, Maja, KARBA, Rihard. Hierarchically structured educational projects. WSEAS transactions on advances in engineering education, 2006, vol. 3, iss. 5, str. 296-303. 4. ATANASIJEVIĆ-KUNC, Maja, KARBA, Rihard. Multivariable control design with expert-aided support. WSEAS transactions on systems, 2006, vol. 5, iss. 10, str. 2299-2306 5. ATANASIJEVIĆ-KUNC, Maja, BELIČ, Aleš, KARBA, Rihard. Optimal multivariable control design using genetic algorithms. EUROSIM simulation news Europe,2007, vol. 17, no. 3/4, str. 41-45. | | | | | |