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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Analiza linearnih sistemov | | | | | | | | | | | | | | |
| **Course title:** | | | Linear Systems Analysis | | | | | | | | | | | | | | |
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| **Študijski program in stopnja**  **Study programme and level** | | | | | **Študijska smer**  **Study field** | | | | | | | | **Letnik**  **Academic year** | | **Semester**  **Semester** | | |
| Univerzitetni študijski program prve stopnje Elektrotehnika | | | | | **Avtomatika** | | | | | | | | 3. | | zimski | | |
| 1st cycle academic study programme Electrical Engineering | | | | | **Control Systems** | | | | | | | | **3.** | | **winter** | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Obvezni- strokovni/compulsory professional | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64124 | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| **45** |  | | | **45** | | |  | | | |  | | | **85** | |  | **7** |
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| **Nosilec predmeta / Lecturer:** | | | | | Franjo Pernuš | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | Slovenski/Slovenian | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | Slovenski/Slovenian | | | | | | | | | | | |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | | | | | | | | |  | **Prerequisits:** | | | | | | | |
| Vpis letnik. | | | | | | | | |  | Enrolment in the year of the course. | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| Uvod. Razvrščanje sistemov. Predstavitev življenjskega cikla sistema.  Analiza sistemov v časovnem prostoru. Klasični pristop preko reševanja diferencialne enačbe. Prenosna funkcija. Analiza s pomočjo konvolucije. Stabilnost BIBO, Routhov kriterij.  Analiza sistemov v frekvenčnem prostoru. Frekvenčna karakteristika. Bodejev diagram. Polarni diagram. Diagrami osnovnih členov.  Obravnava zveznih sistemov v prostoru stanj. Zapis v prostoru stanj. Izbira spremenljivk stanj. Povezava med prenosno funkcijo in zapisom v prostoru stanj. Odziv linearnega časovno nespremenljivega sistema. Računanje matrike prehajanja stanj. Tirnice v prostoru stanj. Ravnotežne točke. Določevanje stabilnosti po metodi Ljapunova. Transformacije spremenljivk stanja. Kanonične oblike. Vodljivost in spoznavnost sistemov.  Osnovni sistemski pristopi obravnave linearnih električnih vezij.  Opazovalnik stanj. Osnovne sheme. Metode načrtovanja s predpisanimi poli. Načrtovanje preko spoznavnostne kanonične oblike. Ackermannova formula.  Področja uporabe sistemske teorije s primeri iz biomedicine, tehnike, ekonomije, managementa, itd.  Analiza bioloških sistemov. Matematično modeliranje bioloških sistemov. Linearni modeli bioloških sistemov. Analiza bioloških sistemov v časovnem in frekvenčnem prostoru. Analiza bioloških sistemov v prostoru stanj. | | | | | | | |  | | Introduction. What are systems? Classification of systems.  Analysis of systems in the time domain. Linear differential equations. Solving linear differential equations. System transfer function. Convolution of linear continuous-time systems. Stability of continuous-time linear systems. Routh-Hurwitz stability criterion.  Analysis of systems in the frequency domain. Characteristics of the frequency response function. Bode diagrams. Polar diagrams.  State space approach. State space models. State variables and state vector. General solution of the state equation in the time domain. State transition matrix. State space model and the transfer function. Stability analysis in state space. State space canonical forms.  Controllability and observability.  Analysis of linear electrical circuits.  Applications of systems theory. Examples from biomedicine, engineering, economy, management, etc.  Analysis of biological systems. Mathematical modelling of biological systems. Linear models. Analysis of biological systems in the time and frequency domains. State space analysis of biological systems. | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. Antsaklis P.J., Michel A.N. A Linear Systems Primer, Birkhäuser Boston, 2007 2. Strum R.D., Kirk D.E. Contemporary Linear Systems Using MATLAB, Pws Bookware Companion Series, 1999 3. Gajič Z. Linear Dynamic Systems and Signals, Prentice hall, 2002 4. Hoppensteadt F.C., Peskin C. Modeling and Simulation in Medicine and the Life Sciences, Springer; 2. izdaja, 2004 5. Študijsko gradivo izvajalcev predmeta, predloge predavanj in laboratorijskih vaj | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Ilustrirati razširjenost oz. multidisciplinarnost področja zveznih sistemov.  Prikazati področje analize sistemov.  Podati osnovne koncepte analize zveznih sistemov.  Podati postopke analize sistemov v prostoru stanj.  Ilustrirati področje analize sistemov na primeru bioloških sistemov.  Predstaviti nekatera programska orodja in njihovo uporabnost v podporo obravnavani tematiki. | |  | | The purpose of this course is to provide the students with the basic knowledge and tools of modern linear systems theory in several domains. The students will gain knowledge on modelling, time and frequency domain analysis, state space approach, stability, controllability, and observability. The students will also be introduced to the computational tools for linear systems theory available in MATLAB. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Osnovna znanja o linearnih sistemih, njihovem modeliranju in njihovi analizi | | |  | To provide basic knowledge on linear systems, their modelling, and their analysis. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja, avditorne in laboratorijske vaje, in domače naloge | | |  | Lectures, tutorials, lab work and homework. | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Način: domače naloge, pisni izpit ustni izpit.  Ocene od 1 do vključno 5 so negativne, ocene od 6 do 10 so pozitivne.  Pozitivna ocena domačih nalog je pogoj za pristop k izpitu.  Prispevki k oceni:  domače naloge  pisni izpit  ustni izpit | 10%  70%  20% | | | | Type: homework, written and oral exam.  Negative grades: from 1 to 5, positive grades: from 6 to 10.  Positive evaluation of homework is a prerequisites for the exam.  Contributions to final grade:  homework  written exam  oral exam |
| **Reference nosilca / Lecturer's references:** | | | | | |
| 1. KATRAŠNIK, Jaka, PERNUŠ, Franjo, LIKAR, Boštjan B. A method for characterizing illumination systems for hyperspectral imaging. Optics express, 2013, vol. 21, no. 4, str. 4841-4853.  2. BRATANIČ, Blaž, PERNUŠ, Franjo, LIKAR, Boštjan, TOMAŽEVIČ, Dejan. Real-time rotation estimation using histograms of oriented gradients. PLOS ONE, 2014, vol. 9, no. 3, str. e92137.  3. NAGLIČ, Peter, PERNUŠ, Franjo, LIKAR, Boštjan Likar, BURMEN, Miran. Limitations of the commonly used simplified laterally uniform optical fiber probe-tissue interface in Monte Carlo simulations of diffuse reflectance. Biomedical Optics Express, 2015, vol. 6, no. 10, str. 3973-3988.  4. BREGAR, Maksimilijan, CUGMAS, Blaž, NAGLIČ, Peter, HARTMANN, Daniela, PERNUŠ, Franjo, LIKAR, Boštjan, BURMEN, Miran. Properties of contact pressure induced by manually operated fiber-optic probes. Journal of Biomedical Optics, 2015, vol. 20, no. 12, str. 127002.  5. BRATANIČ, Blaž, PERNUŠ, Franjo, LIKAR, Boštjan, TOMAŽEVIČ, Dejan. Real-time pose estimation of rigid objects in heavily cluttered environments. Computer Vision and Image Understanding, 2015, vol. 141, str. 38-51. | | | | | |