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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Mikroelektronski sistemi | | | | | | | | | | | | | | |
| **Course title:** | | | Microelectronic Systems | | | | | | | | | | | | | | |
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| **Študijski program in stopnja**  **Study program and level** | | | | | **Študijska smer**  **Study field** | | | | | | | | **Letnik**  **Academic year** | | **Semester**  **Semester** | | |
| Podiplomski magistrski študijski program druge stopnje Elektrotehnika | | | | | Elektronika | | | | | | | | 2 | | 1 | | |
| 2nd cycle masters study programme in Electrical Engineering | | | | | Electronics | | | | | | | | 2 | | 1 | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Obvezni-strokovni / Compulsory professional | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64288 | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individual work** | |  | **ECTS** |
| 45 |  | | | 30 | | |  | | | |  | | | 75 | |  | 6 |
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| **Nosilec predmeta / Lecturer:** | | | | | Drago Strle | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | slovenski / Slovenian  angleški / English | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | slovenski / Slovenian  angleški / English | | | | | | | | | | | |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | | | | | | | | |  | **Prerequisites:** | | | | | | | |
| Vpis v letnik predmeta | | | | | | | | |  | Enrolment in the year of the course | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| METODOLOGIJA NAČRTOVANJA: metodologija načrtovanja mikroelektronskih sistemov od zgoraj navzdol in od spodaj navzgor ter uporaba modernih načrtovalskih orodji.  KOMPLEKSNI ANALOGNO/DIGITALNI GRADNIKI: Analogno-digitalni in digitalno-analogni pretvorniki, Fazno sklenjene zanke, mešalniki, fazni detektorji, kompleksni filtri,  MODELIRANJE MIKROELEKTRONSKIH SISTEMOV: Matlab/simulink in VHDL-AMS jezika za opis mešanih analogno-digitalnih sistemov in senzorjev/aktuatorjev, sočasne simulacije kompleksnega mikroelektronskega sistema na različnih nivojih, uporaba orodji za modeliranje in sočasno simulacijo itd.,  PARAZITNI POJAVI: trenutnih ter bodočih tehnoloških procesov (presluh, leakage, zakasnitve, sum, elektro migracija ter omejitve modernih tehnologij)  MEJE CMOS TEHNOLOGIJE: kam vodi zmanjševanje struktur, novi elementi (SET), vpliv na načrtovanje digitalnih in analognih integriranih vezij ter mikro-elektronskih sistemov, optimizacija moči, redundanca,...  IZBRANA POGLAVJA IZ : testiranja, testabilnosti, BIST in zanesljivosti mikroelektronskih sistemov. | | | | | | | |  | | METHODOLOGY OF DESIGN: Top-down and bottom-up microelectronic design methodology and the use of modern CAD tools.  COMPLEX ANALOG/DIGITAL MODULES: A/D and D/A converters, phase locked loops, phase detectors, complex filters, etc.  MODELING OF MICROELECTRONIC SYSTEMS:  Matlab/Simulink and VHDL-AMS description and simulations of mixed-signal microelectronic systems including sensors and actuators, simulations of microelectronic systems on different levels, tools for co-simulations.  PARASITIC EFFECTS: basics effects of leakage, noise, crosstalk in integrated circuits.  LIMITS OF CMOS TECHNOLOGY:  Effects of reducing the channel length, new elements, influence to the design process of digital and analogue integrated circuits and microelectronic systems, power consumption optimisation.  BASICS OF TESTING MICROELECTRONIC SYSTEMS: basics of testability, BIST and reliability of microelectronic systems. | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. P.J. Ashenden, "The systems designers guide to VHDL-AMS," Morgan Kaufmann publ., 2003. 2. R. Plasche, "Integrated Analog-to-digital and Digital-to-analog Converters, "Kluwer Academic publishers, 2002. 3. F. Maloberti, "Data Converters, " Springer, 2007. 4. G.T.A. Kovacs, "Microamchinned transducers source book," McGraw-Hill, 1998. 5. Kopije prosojnic predavanj in navodila za laboratorijske vaje/Copies of lecture slides and instructions for laboratory exercises   <http://lmfe.fe.uni-lj.si/predmeti-vsi/mikroelektronski-sistemi/> | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Glavni cilji predmeta so: Načrtovanje mešanih analogno/digitalnih gradnikov, razumevanje problemov, ki nastanejo pri realizaciji integriranih VLSI mikroelektronskih sistemov in obvladovanje postopkov ter modernih načrtovalskih orodji, jezikov za opisov in modeliranja ter sočasno simulacijo analognih in digitalnih podsistemov ter senzorjev in/ali aktuatorjev. Poleg tega bodo študentje seznanjeni s trendi realizacije mikroelektronskih sistemov v prihodnosti. | |  | | The main objectives are: to learn the basics of the design of mixed-signal integrated circuits and systems, to understand the problems related to the design of mixed-signal integrated VLSI microelectronic systems and to learn modern description language, modern CAD tools, and the simulation of mixed signal microelectronic systems, sensors and actuators.  In addition, the students will get insight into the trends of implementation practices of microelectronic systems in the future. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| **Znanje in razumevanje:**   * Poznavanje teoretičnih osnov pri načrtovanju mešanih analogno digitalnih mikroelektronskih sistemov, * metode modeliranja, analize, sinteze, in simulacij z uporabo CAD orodji za načrtovanje kompleksnih mešanih analogno-digitalnih mikroelektronskih sistemov | | |  | **Knowledge and understanding:**   * Understanding theoretical background for the design of mixed signal analog-digital microelectronic systems * Methods of modelling, analysis, synthesis and simulations using CAD equipment appropriate for complex mixed signal analog-digital microelectronic systems | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| a) Predavanja na katerih se študentje seznanijo z osnovnimi teoretičnimi koncepti, metodami, gradniki in integracijo Mikroelektronskih sistemov. V okviru predavanj se teoretični temelji podkrepijo z računskimi primeri. Nadgradnja so vabljena predavanja priznanih strokovnjakov iz univerz in-ali industrije. V času predavanj skupina študentov predstavi seminarsko nalogo iz tematike.  b) Laboratorijske vaje, kjer se študentje seznanijo s praktičnim pristopom pri načrtovanju preprostega Mikroelektronskega sistema in uporabo modernih visoko-nivojskih načrtovalskih orodji (Matlab/Simulink). | | |  | 1. Lectures to learn the basic theoretical concepts, methods and building blocks and the integration of microelectronic systems. The lectures will include solving selected problems. In addition, invited lectures will take place if possible. During lecture time, each student will present the seminar work according to the selected theme. 2. Laboratory work will consist of practical work related to the design of microelectronic system modelling and simulation using Matlab/Simulink. | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Ocene 1-5 so negativne  Ocene 6-10 so pozitivne  Pozitivna ocena lab. vaj je pogoj za pristop k pisnemu izpitu  Pisni izpit, ustno izpraševanje  Laboratorijske vaje domače naloge, projekt | 60 %  25 %  15 % | | | | Grades 1-5 are negative  Grades 6-10 are positive  Positive grade of Laboratory exercises is a prerequisite for the admission to the written exam  Written and oral exam,  Laboratory exercises  Home works, the project |
| **Reference nosilca / Lecturer's references:** | | | | | |
| 1. STRLE, Drago, NAHTIGAL, Uroš, BATISTELL, Graciele, ZHANG, Vincent Chi, OFNER, Erwin, FANT, Andrea, STURM, Johannes. Integrated high resolution digital color light sensor in 130 nm CMOS technology. *Sensors*, ISSN 1424-8220, Jul. 2015, vol. 15, no. 7, pp. 17786-17807. 2. STRLE, Drago, ŠTEFANE, Bogdan, NAHTIGAL, Uroš, ZUPANIČ, Erik, POŽGAN, Franc, KVASIĆ, Ivan, MAČEK, Marijan, TRONTELJ, Janez, MUŠEVIČ, Igor. Surface-functionalized COMB capacitive sensors and CMOS electronics for vapor trace detection of explosives. *IEEE sensors journal*, ISSN 1530-437X. May 2012, vol. 12, no. 5, pp. 1048-1057. 3. STRLE, Drago, TRONTELJ, Janez. On self-aware mixed-signal systems based on [sigma]-[delta] ADC. *International journal of embedded and real-time communication systems*, ISSN 1947-3176, Apr.-Jun. 2012, vol. 3, no. 2, pp. 92-110. 4. GREGOROVIČ, Alan, APIH, Tomaž, KVASIĆ, Ivan, LUŽNIK, Janko, PIRNAT, Janez, TRONTELJ, Zvonko, STRLE, Drago, MUŠEVIČ, Igor. Capacitor-based detection of nuclear magnetization: Nuclear quadrupole resonance of surfaces. *Journal of magnetic resonance*, ISSN 1090-7807, 2011, vol. 209, no. 1, pp. 79-82. 5. STRLE, Drago, KEMPE, Volker. MEMS-based inertial systems. *Informacije MIDEM*, ISSN 0352-9045, Dec. 2007, year. 37, no. 4, pp. 199-209. | | | | | |