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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Konstruiranje elektronskih naprav | | | | | | | | | | | | | | |
| **Course title:** | | | Construction of Electronic Systems | | | | | | | | | | | | | | |
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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 | | | | | | | | 1 | | 1 | | |
| 2nd cycle masters study programme in Electrical Engineering | | | | | All study fields | | | | | | | | 1 | | 1 | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Izbirni-splošni /elective general | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64253 | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| **45** | **0** | | | **30** | | | **0** | | | | **0** | | | **75** | |  | **6** |
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| **Nosilec predmeta / Lecturer:** | | | | | Marko Jankovec | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | Angleško / English (Slovenski študentje imajo možnost dodatnih posvetov in zgoščenih predavanj v slovenščini) | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | Angleško / English (Slovenski študentje imajo možnost dodatnih posvetov in vaj v slovenščini) | | | | | | | | | | | |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | | | | | | | | |  | **Prerequisites:** | | | | | | | |
| Vpis v letnik. | | | | | | | | |  | Enrolment in the year of the course. | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| Uvod v načrtovanje novih naprav, razvojni cikel izdelkov, faze razvoja trga. Strategije načrtovanja izdelka, časovni in finančni načrt. Električne, mehanske, termične in oblikovne zahteve izdelka. Ekonomski vidiki razvoja, gradnje, vzdrževanja in razgradnje elektronskih naprav.  Zakonske omejitve elektronskih izdelkov. Sistem standardizacije, evropski harmonizirani standardi. CE znak. Svetovni regulatorji kvalitete in varnosti izdelkov. Varnostne in EMC direktive in standardi.  Osnove EMC, načini sklapljanja motenj, bližnje in daljne elektromagnetno polje, sofazni in diferencialni signali, meritve EMC.  Pasivne in aktivne elektronske komponente, integrirana vezja. Oblike komponent in oznake. Napajalni viri. Standardne napajalne napetosti in logični nivoji. Usmerniki, stabilizatorji in reference. Baterije in akumulatorji. Električne povezave, priključki, kabli, tipi in oznake. Osnove zanesljivosti elektronskih naprav in sistemov, vplivi okolja, analiza obremenitve elementov, podatkovne baze.  Tehnologije tiskanih vezij, materiali, izvedbe in proizvodnja. Načrtovanje tiskanih vezij, orodja in pristopi. Strategije postavitve in povezovanja komponent. Tehnike načrtovanja za EMC, izločanje in filtriranje motenj. Blokiranje napajanja. Povezovanje mas in napajanja. Izločanje motenj na signalnih in napajalnih linijah in priključkih. Masne površine. Večslojna tiskana vezja.  Tehnike in komponente za zaščito pred elektrostatičnimi izpraznitvami in prenapetostjo. Integriteta signalov. Prenosne linije in zaključitve. Presluh med linijami.  Priprava načrta in datotek za serijsko proizvodnjo tiskanega vezja in strojnega polaganja z upoštevanjem omejitev tehnologij.  Ohišja naprav. Standardi, oblike, združljivost ohišij. Upravljanje s toploto. Hladilna telesa in materiali. Tehnologije in postopki za oblikovanje ohišij.  Oklopi in ozemljitve naprav in kablov. | | | | | | | |  | | Introduction into design of new products, product development cycle, market development phases. Design strategies, time and financial plan. Electrical, mechanical, thermal and design requirements. Economic aspects of development, construction, maintenance and disposal of electronic devices.  Legal restrictions of electronic products. Standardization system, European harmonized standards. The CE marking. Worldwide product quality and safety regulators. Safety and EMC directives and standards.  EMC basics, noise coupling paths, near and far electromagnetic field, common and differential mode signals, measurements of the EMC.  Passive and active electronic components, integrated circuits. Footprints and markings.  Power supply sources. The standard supply voltage and logic levels. Rectifiers, stabilizers and references. Batteries and accumulators. Electrical connections, connectors, cables, types and markings. Basics of reliability of electronic devices and systems, environmental influences, part stress analysis, reliability databases.  Printed circuit board technologies, materials, types and manufacturing. PCB design, tools and approaches. PCB layout and routing strategies. PCB design techniques for EMC, noise filtering and decoupling. Power supply decoupling. Ground routing and power distribution. Noise suppression on power and signal lines and connectors. Ground planes. Multilayer PCBs.  Electrostatic discharge and surge protection techniques and devices. Signal integrity. Transmission lines and impedance matching. Signal crosstalk. PCB design and output files for mass production and pick&place considering technology limitations.  Device housing. Standards, formats, compatible housings. Thermal management. Heat sinks and materials. Techniques and procedures for the housing design. Shielding and grounding of devices and cables. | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. Jankovec M., Konstruiranje elektronskih naprav, slikovno gradivo in zapiski predavanj, Ljubljana, 2016. 2. Henry W. Ott, Electromagnetic Compatibility Engineering, Wiley-Interscience, ISBN 978-0-470-18930-6, New York, 2009. 3. Howard W. Johnson, Martin Graham, High-Speed Digital Design, A Handbook of Black Magic, Prentice Hall PTR, New Jersey 4. Lee. W. Ritchey, Right the first time, Speeding edge, ISBN-0-9741936-0-7, 2003 5. Mark I. Montrose, Printed Circuit Board Design Techniques for EMC Compliance, Wiley-Interscience IEEE, ISBN 0-7803-5376-5, New York, 2000. 6. Mark I. Montrose, EMC and the Printed Circuit Board – Design, Theory and -Layout Made Simple, Wiley-Interscience IEEE, ISBN 0-7803-4703-N, New York, 1996. 7. Tim Williams, EMC for Product Designers, Third edition, ISBN 0 7506 4930 5, 2001. | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Študentje naj bi pridobili teoretična in praktična znanja, ki so potrebna za načrtovanje elektronskih naprav v skladu z veljavnimi predpisi in standardi. | |  | | Students should acquire skills and theoretical knowledge to design electronic devices in accordance with applicable regulations and standards. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Ob uspešno zaključenih študijskih obveznosti pri tem predmetu naj bi študentje bili sposobni   * izbrati veljavne standarde, ki jim mora naprava ustrezati glede na veljavno zakonodajo in tip naprave. * izbrati najustreznejše materiale in tehnologijo izdelave in opremljanja tiskanega vezja. * načrtati tiskano vezje glede na dano shemo z upoštevanjem dobre inženirske prakse za doseganje združljivosti vezja z veljavnimi standardi in proizvodnimi tehnologijami. * uporabljati računalniške programe za simulacijo in načrtovanje električne sheme in tiskanega vezja. * izbirati materiale, topologijo, komponente in izračunati njihove vrednosti za namen filtriranja in dušenja motenj. * izbrati in uporabiti najprimernejšo topologijo in zaključitve električnih povezav glede na tip signala. * identificirati najverjetnejši izvor težav v zvezi z elektromagnetno združljivostjo v vezju in ga z ustreznimi ukrepi zmanjšati. | | |  | On successful completion of this module, students should be able to   * choose the applicable standards to which the device must comply according to the currently valid legislation and the type of the device. * select appropriate materials and technology for the manufacturing and assembly of printed circuit boards. * design a printed circuit board according to the given scheme with respect to good engineering practice to achieve compatibility with the applicable standards and to the production technologies. * use computer programs for the simulation and design of electrical schemes and printed circuit boards. * select materials, topology, components and calculate their values for the purpose of noise filtering and suppression. * select the best topology and the termination of the electrical connections according to the type of signal. * identify the most likely source of problems related to electromagnetic compatibility in the circuit and suppress it with the most appropriate means. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja, laboratorijske vaje, projektno delo. | | |  | Lectures, laboratory exercises, project work. | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Način: praktični projekt, pisni izpit.  Ocene od 1 do vključno 5 so negativne, ocene od vključno 6 do 10 so pozitivne.  Za pristop k pisnemu izpitu je potrebno uspešno opraviti vse laboratorijske vaje predmeta.  Praktični projekt se lahko izvede na dva načina:   * v obliki samostojno projektne naloge, ki jo kandidat izdela najkasneje do konca tekočega semestra * v obliki praktičnega reševanja danega problema v omejenem času   Za končno pozitivno oceno morata biti obe delni oceni pozitivni.  Prispevki k oceni:   * praktični projekt * pisni izpit | 50%  50% | | | | Type: practical project, written exam  Negative grades: from 1 to 5, positive grades: from 6 to 10.  A prerequisite for the exam is a positive evaluation of all laboratory exercises.  Practical project can be done in two ways:  - In the form of an individual project work, which the candidate completes by the end of the current semester  - In the form of solving a given practical problem in a limited time  A prerequisite for a positive final grade are both positive partial grades.  Contributions to the final grade:   * practical project * written exam |
| **Reference nosilca / Lecturer's references:** | | | | | |
| 1. MATIČ, Gašper, JANKOVEC, Marko, JURMAN, David, TOPIČ, Marko. Feasibility study of attitude determination for all-rotating unmanned aerial vehicles in steady flight. Journal of intelligent & robotic systems, ISSN 0921-0296, 2015, vol. , no. , str. 1-20. 2. JANKOVEC, Marko, TOPIČ, Marko. Intercomparison of temperature sensors for outdoor monitoring of photovoltaic modules. Journal of solar energy engineering, ISSN 0199-6231, Aug. 2013, vol. 135, no. 3, str. 1-7. 3. HERMAN, Matic, JANKOVEC, Marko, TOPIČ, Marko. Optimisation of the I-V measurement scan time through dynamic modelling of solar cells. IET renewable power generation, ISSN 1752-1416. [Print ed.], 2013, vol. 7, no. 1, str. 63-70. 4. ANDREJAŠIČ, Tine, JANKOVEC, Marko, TOPIČ, Marko. Comparison of direct maximum power point tracking algorithms using EN 50530 dynamic test procedure. IET renewable power generation, ISSN 1752-1416. [Print ed.], 2011, vol. 5, no. 4, str. 281-286. 5. KURNIK, Jurij, JANKOVEC, Marko, BRECL, Kristijan, TOPIČ, Marko. Outdoor testing of PV module temperature and performance under different mounting and operational conditions. Solar energy materials and solar cells, ISSN 0927-0248. [Print ed.], Jan. 2011, vol. 95, no. 1, str. 373-376. | | | | | |