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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Vezja pri visokih frekvencah | | | | | | | | | | | | | |
| **Course title:** | | | Circuits at High Frequencies | | | | | | | | | | | | | |
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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:** | | | | | | | | | | | 64308 | | | | | |
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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 |
|  | | | | | | | | | | | | | | | | |
| **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:** | | | | | | | |  | **Prerequisits:** | | | | | | | |
| Vpis v letnik predmeta | | | | | | | |  | Enrolment in the year of the course | | | | | | | |

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| **Vsebina:** |  | **Content (Syllabus outline):** |
| 1. Uvod: spektri, področja, električne dimenzije, tehnologije, načrt dela. 2. Visokofrekvenčni sistemi: WLAN, GSM, GPS, Senzorji, VF Biomedicinske naprave, Reziskovalne naprave (NMR), skupni VF moduli. 3. Kratka ponovitev teoretičnih osnov: valovanje, linije, abstraktni modeli (S in X parametri), impedančne matrike, ABCD matrike, Smithov diagram, ubiranje, Modeliranje, CAD orodja in simulacije, meritve. 4. Načrtovanje visokofrekvenčnih gradnikov: Modeliranje, CAD orodja, simulacije, načrtovanje aktivnih in pasivnih VF vezji, digitalna vezja pri visokih frekvencah, VF meritve. 5. Osnove elektromagnetne združljivosti: osnovni pojmi, odpravljanje motenj, zaščita pred motnjami, zagotavljanje elektromagnetne združljivosti, meritve, orodja za načrtovanje. |  | 1. Introduction: spectrums, ranges, electrical dimensions, technologies, plan of attack 2. RF systems: WLAN, GSM, GPS, Sensors, RF Biomedical systems, research equipmnet (NMR), common RF modules. 3. Short introduction to theory basics: waves, lines, abstract models, S and X parameters, imedance and admitance matrices, ABCD matrix, Smith chart, tunning, modelling, CAD tools, RF simulations, RF measurements. 4. Design of RF modules: Modelling, CAD tools, simulations, design of passive and active RF circuits, digital circuits at high frequencies, measurements at high frequencies. 5. Basics of electromagnetic compatibility: Introduction, suppressing EMC emission, protection against EMC interference, EMC comnpatibility, measurements, CAD tools. |

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| **Temeljni literatura in viri / Readings:** | | |
| 1. M. Steer, Microwave and RF design, A systems approach, SciTech publishing, 2013. 2. G. B. Roberto Sorentino, Microwave and RF Engineering, New York: Wiley, 2010. 3. D. M. Pozar, Microwave engineering, Wiley, 2012. 4. B. Razavi, RF microelectronics, New York: Pearson international, 2012. 5. R. C. Paul, Electromagnetic compatibility, Wiley, 1992. 6. Kostevc, D. Poglavja iz mikrovalov, Založba FE in FRI, Ljubljana, 2005 7. 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/vezja-pri-visokih-frekvencah/> | | |
| **Cilji in kompetence:** |  | **Objectives and competences:** |
| Spoznavanje specifičnih elementov vezji in sistemov za visoke frekvence ter spoznavanje specifičnih metod analize, sinteze, načrtovanja CAD orodji in meritev za načrtovanje visokofrekvenčnih vezji in sistemov. Spoznavanje nekaterih VF systemov.  Vpogled v osnovne koncepte elektromagnetne združljivosti |  | Understanding basic elements of RF circuits and systems, and specific methods of analysis, synthesis, design and CAD tools for design of RF circuits and systems.  Understanding the basic concepts of Electromagnetic compatibility. |

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| **Predvideni študijski rezultati:** | |  | **Intended learning outcomes:** | |
| **Znanje in razumevanje:**  Poznavanje metod analize, sinteze, simulacij in uporabo izbranih CAD orodji za načrtovanje viskokfrekvečnih vezji in sistemov ter osnovnih merilnih metod za vezja pri visokih frekvencah.  Poznavanje osnovnih konceptov elektromagnetne združljivosti, metod za odpravljnaje motenj in zagotavljnja EMC kompatibilnosti. | |  | **Knowledge and understanding:**  Knowledge of analysis, synthesis, simulations and the use of selected CAD tools for the design and measurements of RF circuits and systems.  Knowledge of basic concepts of electromagnetic compatibility, methods to reduce the disturbances and assurance for EMC compatibility. | |
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| **Metode poučevanja in učenja:** | |  | **Learning and teaching methods:** | |
| Predavanja in laboratorijske vaje sestavljene iz dveh delov: uporaba CAD orodji pri načrtovanju realnih VF vezji ter meritve VF vezji in sistemov. | |  | Lectures and laboratory work composed of two parts: the use of CAD tools for design of RF circuits and specific measurements of RF circuits and systems. | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | **Assessment:** |
| Ocenjevalna lestvica 1-10 (6-10 pozitivno, 1-5 negativno)  Pozitivna ocena lab. vaj je pogoj za pristop k pisnemu izpitu  Prispevki k oceni:  pisni izpit, ustno izpraševanje,  laboratorijske vaje  domače naloge in projekt | 60 %  25 %  15 % | | | Grading scale 1-10 (6-10 positive, 1-5 negative)  Positive grade of laboratory exercises is a prerequisite for admission to the written exam.  Contributions to final grade:  written and oral exam  laboratory work  homework and 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. 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. 4. STRLE, Drago, KEMPE, Volker. MEMS-based inertial systems. *Informacije MIDEM*, ISSN 0352-9045, Dec. 2007, year. 37, no. 4, pp. 199-209. 5. KOSELJ, Jure, STRLE, Drago. Electromagnetic compatibility in integrated circuits: a review. *Informacije MIDEM*, ISSN 0352-9045, Mar. 2009, year. 39, no. 1, pp. 16-21. | | | | |