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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Modul F: Elektronske napajalne naprave | | | | | | | | | | | | | | |
| **Course title:** | | | Module F: Modern Power Supplies | | | | | | | | | | | | | | |
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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 | | 2 | | |
| 2nd cycle masters study programme in Electrical Engineering | | | | | All study fields | | | | | | | | 1 | | 2 | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Izbirni-strokovni /elective professional | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64268 | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| **30** |  | | | **45** | | |  | | | |  | | | **75** | |  | **6** |
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| **Nosilec predmeta / Lecturer:** | | | | | Peter Zajec | | | | | | | | | | | | |
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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 v letnik predmeta | | | | | | | | |  | Enrolment in the year of the course | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| a) Visokofrekvenčni DC/DC pretvorniki.  - Detajlna analiza visokofrekvenčnih DC/DC pretvornikov, pretvorniki in z galvansko ločitvijo, pretvorniki z vsiljeno napetostjo, pretvorniki z vsiljenim tokom, resonančni pretvornik,  - Stikalne izgube, razbremenilna vezja, prožilna vezja močnostnih stikal,  - Zahteve za krmiljenje in regulacijo DC/DC pretvornikov, modulacijski principi, optimizacija regulacijskih zank,  - Dimenzioniranje, kriteriji izbire osnovnih elektronskih komponent za obratovanje v stikalnem načinu delovanja, izračun magnetnih komponent, načrtovanje pripadajočih elektronskih vezij za merjenje in obdelavo električnih veličin v pretvorniških vezjih,  - Simulacija pretvorniških vezij,  b) Pretvorniška vezja za pogon enosmernega, asinhronskega, BLDC motorja  Pregled pretvorniških vezij, analiza delovanja, modulacijski principi  c) Sistemi brezprekinitvenega napajanja (UPS) ter naprav (PFC) in ukrepov (aktivno in pasivno filtriranje) za zmanjšanje onesnaženja omrežja,  d) Elektromagnetna kompatibilnost, izvori in načini razširjanja elektromagnetnih motenj, ukrepi in komponente za zmanjšanje EM motenj (načrtovanje tiskanine visokofrekvenčnih stikalnih pretvornikov, kriteriji izbire in izračun elektronskih komponent za slabljenje EM motenj), postopki in preizkusi ugotavljanja skladnosti z EMC | | | | | | | |  | | a) Review of High-frequency DC/DC converters and their detail analysis. Converters, with galvanic transformer, resonant converter  - Switching losses, snubber circuits, triggering circuit for IGBT and MOSFETs  - Requirements for steering and control of DC/DC converters, modulation principles, optimization of control loops  - Design, criteria for selection of basic electronic components to operate in switching mode, the calculation of magnetic components, design of associated electronic circuits for measurement and processing of electrical quantities in power electronics circuits  - Simulation of power electronics circuits.  b) Review of converters to drive DC, induction, BLDC Motor and their operation principles.  c) Uninterruptible power systems (UPS), plants (PFC) and measures (active and passive filtering) to minimize contamination of the network.  d) Electromagnetic compatibility, sources and methods of propagation of electromagnetic disturbances, actions and components to reduce the EM interference. | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. M. Milanovič: Uvod v močnostno elektroniko, učbenik, Univerza v Mariboru, Fakulteta za Elektrotehniko računalništvo in informatiko, Maribor, 1997. 2. P. Zajec: Interna skripta, Univerza v Ljubljani, Fakulteta za Elektrotehniko. 3. B. K. Bose, Power Electronics And Motor Drives: Advances and Trends. Academic Press, 2010. 4. J. Jacob, Power Electronics: Principles and Applications. Cengage Learning, 2001. 5. T. L. Skvarenina, The Power Electronics Handbook. CRC Press, 2001. 6. J. Kasakian, M. Schlecht, G. Vergese: Principle of power electronics, MIT, Academic press, 1991. 7. T. Williams, EMC for Product Designers. Elsevier Science, 2011. | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Združitev podsestavov energetske elektronike in podsestavov industrijske elektronike v napajalnih napravah in sistemih s stališča zanesljivega in varnega obratovanja. Podati detajlnejši vpogled v delovanje in načrtovanje stikalnih napajalnih sistemov od izbire močnostnih elementov do optimizacije internih regulacijskih zank.  Usposobiti študenta za poglobljeno analizo pretvorniških naprav in za samostojno načrtovanje, realizacijo in optimizacijo stikalnih pretvorniških naprav. | |  | | Merging the power electronics sub-assemblies and subassemblies for industrial electronics in power devices and systems in terms of reliable and safe operation. Deepen insight into the design and operation of switching power supply systems from the selection of circuit elements to optimize the internal control loops. To prepare the students for in-depth analysis of power electronics devices and to independently design, realization and optimization of switching converter systems. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Poglobljeno razumevanje delovanja pretvornikov in njihovih fizikalnih omejitev.  Poznavanje analiznih in načrtovalskih korakov pri reševanju specifičnih problemov pretvorniških vezij. | | |  | In-depth understanding of the converters operation and their physical limitations.  To gain knowledge for deeper analysis and design steps in solving specific problems of power electronic converters. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja, avditorne vaje za poglabljanje teoretičnih osnov, laboratorijske vaje za samostojno praktično realizacijo vezij in izdelavo dokumentacije. | | |  | Lectures and tutorials to deepen the theoretical bases, laboratory exercises for practical realization and validation of circuits. Construction documentation. | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Pisni del izpitaNačin: laboratorijske vaje, pisni izpit, 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  pisni izpit  ustni izpit | 20%  40%  40% | | | | Type: laboratory exercises, written exam, 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.  Contributions to final grade:  laboratory exercises  written exam  oral examination |
| **Reference nosilca / Lecturer's references:** | | | | | |
| 1. PETKOVŠEK, Marko, LEBAN, Aleš, NEMEC, Mitja, VONČINA, Danijel, ZAJEC, Peter. Series active power filter for high-voltage synchronous generators, Informacije MIDEM, ISSN 0352-9045, Dec. 2013, vol. 43, no. 4, str. 228-234. 2. FLISAR, Uroš, VONČINA, Danijel, ZAJEC, Peter. Voltage sag independent operation of induction motor based on Z-source inverter, Compel, ISSN 0332-1649, 2012, vol. 31, no. 6, str. 1931-1944. 3. RUPAR, Uroš, LAHAJNAR, Franci, ZAJEC, Peter. Iterative-learning-based torque-ripple compensation in a transverse flux motor, IET control theory & applications, ISSN 1751-8644, 2012, vol. 6, no. 3, str. 341-348. 4. PETKOVŠEK, Marko, KOSMATIN, Peter, ZEVNIK, Ciril, VONČINA, Danijel, ZAJEC, Peter. Measurement system for testing of bipolar plates for PEM electrolyzers, Informacije MIDEM, ISSN 0352-9045, mar. 2012, letn. 42, št. 1, str. 60-67. 5. 5. OSTROŽNIK, Simon, BAJEC, Primož, ZAJEC, Peter. A study of a hybrid filter, IEEE transactions on industrial electronics, ISSN 0278-0046, Mar. 2010, vol. 57, no. 3, str. 935-942. | | | | | |