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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Energetska elektronika | | | | | | | | | | | | | | |
| **Course title:** | | | Power Electronics | | | | | | | | | | | | | | |
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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 | | | | | **Energetika in mehatronika** | | | | | | | | 3. | | letni | | |
| 1st cycle academic study programme Electrical Engineering | | | | | **Power Engineering and Mechatronics** | | | | | | | | **3.** | | **summer** | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Obvezni - strokovni/ compulsory professional | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64164 | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| **60** |  | | | **30 (lab)** | | |  | | | |  | | | **85** | |  | **7** |
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| **Nosilec predmeta / Lecturer:** | | | | | Danijel Vončina, Peter Zajec | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | slovenski | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | slovenski | | | | | | | | | | | |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | | | | | | | | |  | **Prerequisits:** | | | | | | | |
| Vpis v letnik. | | | | | | | | |  | Enrolment in the year of the course. | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| a) Močnostna polprevodniška stikala.  Obratovalne lastnosti, statične in dinamične lastnosti močnostnih elementov: dioda, tiristor, GTO, MOSFET, IGBT. Hlajenje polprevodniških močnostnih stikal, tranzientna termična impedanca, termični model hladilnega sistema.  b) Osnovna pretvorniška vezja in njihovo krmiljenje.  Enofazna in večfazna usmerniška vezja z nekrmiljenimi in krmiljenimi stikali, delovanje pri različnih vrstah obremenitev (R, RL in RL z aktivnim virom), delovanje pri zveznem in trganem toku, vpliv prostotečne diode, delovna, jalova in navidezna moč, faktor moči, vpliv impedanc na strani vira, komutacija.  c) Presmerniki  pretvorniki za znižanje in zvišanje napetosti, pretvornik navzdol, pretvornik navzgor, zaporni pretvornik, polmostični in mostični pretvornik, krmiljenje presmernikov.  d) Enofazna in večfazna razsmerniška vezja. razvrstitev pretvornikov, pulzno-širinska modulacija in drugi modulacijski principi.  e) Resonančni pretvorniki, preklapljanje v breztokovnem ali breznapetostnem stanju.    f) pretvorniki večjih moči z neposredno pretvorbo električne energije (ciklokonverter, matrični pretvornik).  g) Pretvorniške naprave v energetiki, pasivne in aktivne kompenzacijske naprave, aktivni močnostni filtri. | | | | | | | |  | | a) Power semiconductor devices.  Properties, static and switching characteristics of power semiconductor devices: Diode, Thyristor, Triac, GTO, MOSFET, IGBT. Cooling of of power semiconductors, thermal impedance, thermal model of the cooling system.  b) Fundamentals of power converters and control principles.  Single- and multiphase AC/DC half and fully controlled converters with R, RL and RLE loads, continuous and discontinuous modes of operation, influence of freewheeling diode, active and reactive power, power factor, effect of source impedance commutation.  c) DC/DC converters, principles of step-down and step-up converters, analysis of buck, boost, buck-boost, half- and full-bridge converters, control of DC/DC converters.  d) Single- and multiphase DC/AC converters. PWM and other modulation principles, single and multilevel converters.  e) Resonant converters, soft switching techniques (ZVS and ZCS).  f) high power converters without DC link (cycloconverters, matrix converters).  g) Applications of power converters in the field of power systems (passive and active compensators, active power filters). | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. J.Nastran: Močnostna elektronika-interna skripta, Univerza v Ljubljani, Fakulteta za elektrotehniko, Ljubljana, 2006  2. N. Mohan: Power Electronics - A first course, John Wiley & Sons, 2012  3. F. Lin Luo, H. Ye: Advanced DC/DC converters, CRC Press, New York 2003  4. N. Mohan, T. M. Undeland, W. P. Robbins: Power Electronics: Converters, Applications and 5. Design, John Wiley & Sons, New York, 1989  6. T. Skvarenina: Power electronics handbook, CRC Press, New York, 2002  7. M. H. Rashid: Power electronics handbook, Academic Press, New York, 2001. | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Pri predmetu bo študent pridobil znanja s področja močnostne elektronike, ki jih bo potreboval pri nadaljnjem magistrskem študiju elektrotehnike:  - polprevodniška močnostna stikala in njihove statične in dinamične karakteristike,  - osnovne izvedbe močnostnih stikalnih pretvornikov in njihovo delovanje  - krmiljenje in regulacija polprevodniških pretvornikov.  Cilj predmeta je tudi usposobiti študenta za samostojno analizo delovanja pretvorniških naprav. | |  | | In this course students will learn basic competence of the following areas of power electronics needed in the master courses in the Electrical Engineering:   * power electronic devices and their static and dynamic characteristics, * basic converter topologies and and their performance and * basic converter control principles.   The student will be able to analyze performance of the power converters. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Študent bo lahko načrtoval osnovna vezja na področju močnostne elektronike. Znal bo ovrednotiti in interpretirati vrednosti izmerjenih veličin. Sposoben bo reševati inženirske izzive na področju močnostne elektronike. | | |  | Student will be able to design fundamental power electronic circuits.  Student will be able to evaluate and interpret experimental data and reach conclusions.  Student will be able to solve power electronics related engineering problems. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja, reševanje praktičnih nalog laboratorijske vaje v manjših skupinah (delo pod napetostjo), ki obsegajo sestavljanje in merjenje električnih veličin v različnih obratovalnih stanjih pretvornikov ter izdelava poročil. | | |  | Lectures, solving of applied problems regarding power electronics, laboratory exercises in small groups (danger of high voltage), practical work includes building and testing of different power converters and report writing. | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Opravljene laboratorijske vaje so pogoj za pristop h končnemu izpitu. Laboratorijske vaje, izpit. Ocenjevalna lestvica: Ocene od 1 do vključno 5 so negativne, ocene od 6 do 10 so pozitivne.  Pozitivna ocena laboratorijskih vaj je pogoj za pristop k izpitu.  Prispevki k oceni:  laboratorijske vaje 30%  izpit 70% | 30%  70% | | | | Student must complete the laboratory work before the final exam.  Type: laboratory exercises, 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 30%  exam 70% |
| **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 = Serijski aktivni močnostni filter za visokonapetostne sinhronske generatorje. 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. KOSMATIN, Peter, MILJAVEC, Damijan, VONČINA, Danijel. A novel control strategy for the switched reluctance generator. Przeglęad Elektrotechniczny, ISSN 0033-2097, 2012, rok 88, no. 7a, str. 49-53.  4. MODRIJAN, Gorazd, PETKOVŠEK, Marko, ZAJEC, Peter, VONČINA, Danijel. Precision B-H analyser with low THD secondary induced voltage. IEEE transactions on industrial electronics, ISSN 0278-0046. [Print ed.], Jan. 2008, vol. 55, issue 1, str. 364-370.  5. PEVEC, Boštjan, BAJEC, Primož, NASTRAN, Janez, VONČINA, Danijel. Optimizacija navorne karakteristike elektronsko komutiranega motorja v hibridnem pogonu = Torque characteristic optimization of brushless DC motor in the hybrid vehicle. Informacije MIDEM, ISSN 0352-9045, sep. 2007, letn. 37, št. 3, str. 182-188. | | | | | |