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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Krmiljenje in regulacija elektronsko komutiranih motorjev | | | | | | | | | | | | | | |
| **Course title:** | | | Control of Electronically Commutated Motors | | | | | | | | | | | | | | |
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| **Študijski program in stopnja**  **Study programme and level** | | | | | **Študijska smer**  **Study field** | | | | | | | | **Letnik**  **Academic year** | | **Semester**  **Semester** | | |
| doktorski študijski program tretje stopnje Elektrotehnika | | | | | Ni smeri | | | | | | | | 1 | |  | | |
| 3rd cycle: doctoral study programme Electrical Engineering | | | | |  | | | | | | | |  | |  | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | izbirni/elective | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64832 | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| **30** |  | | |  | | |  | | | |  | | | **95** | |  | **5** |
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| **Nosilec predmeta / Lecturer:** | | | | | Prof. dr. Danjel Vončina | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | Slovenski/Slovenian | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | |  | | | | | | | | | | | |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | | | | | | | | |  | **Prerequisits:** | | | | | | | |
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| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| Princip delovanja in fizikalni model enosmernega elektronsko komutiranega motorja s trajnimi magneti. Princip delovanja in fizikalni model preklopnega reluktančnega motorja. Principi krmiljenja unipolarnih, bipolarnih in bifilarnih izvedb koračnih motorjev. Mostična, polmostična in asimetrična pretvorniška vezja z različnim številom stikalnih elementov za napajanje elektronsko komutiranih motorjev. Krmiljenje elektronsko komutiranih motorjev. Optimizacija krmiljenja z nastavljanjem kota prevajanja tranzistorjev. Optimizacija navorne karakteristike. Ukrepi za zmanjšanje valovitosti navora. Senzorji za merjenje vrtilne hitrosti. Brezsenzorske metode za določanje vrtilne hitrosti rotorja. Principi regulacije faznih tokov. Regulacija vrtilne hitrosti z različnimi izvedbami regulatorjev. | | | | | | | |  | | Principle of operation and modeling of the brushless permanent magnet motor. Principle of operation and modeling of the switched reluctance motor. Principle of operation of the unipolar, bipolar and bifilar wound stepper motor. Bridge, half-bridge and asymmetric switched-mode power converter topologies with different number of switches for power supply of brushless motor. 120° el. and 180° el. angle switch-on control mode of brushless motor. Optimization of brushless motor control algorithm by magnetic flux weakening method and the modification of the switch-on angle. Optimization of torque-speed characteristic. Methods for cogging torque reduction. Sensors for position and speed detection of the rotor. Sensorless control of brushless motors. Phase current control. Design and implementation of rotor speed and motor torque controllers. | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| [1] Bose B K (2002) Modern Power Electronics and AC Drives. Prentice Hall  [2] Krishnan R (2001) Switched Reluctance Motor Drives. CRC Press  [3] Krause PC, Wasynczuk O, Sudhoff SD (2002) Analysis of Electric Machinery and Drive Systems. John Wiley & Sons  [4] Luo FL, Ye H (2004) Advanced DC/DC converters. CRC Press  [5] Ibrahim D (2006) Microcontroller Based Appliied Digital Control. John Wiley & Sons  [6] Miller JM (2004) Propulsion Systems for Hybrid Vehicles. The institution of Electrical Engineers IEE. London  [7] Doncker R, Pulle D, Veltman A (2011) Advanced in Electrical Drives. Springer  [8] Wach P (2011) Dynamics and Control of Electrical Drives. Springer  [9] Sozanski K (2013) Digital Signal Processing in Power Electronics Control Circuits. Springer | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Cilj predmeta je poznavanje novih pristopov pri krmiljenju in regulaciji električnih in mehanskih veličin elektronsko komutiranih motorjev. Študent bo sposoben samostojno načrtovati različne tipe močnostnih polprevodniških pretvornikov glede na izbran elektronsko komutirani motor in izdelati optimalni krmilno-regulacijski algoritem za doseganje želenih parametrov elektromotorskega pogona. | |  | | The objective of the course is to equip students with knowledge of modern control principles of brushless permanent magnet and switched reluctance motors. Special attention will be given to current, speed and torque control algorithms of brushless motors in order to achieve optimal parameters of the electric motor drive. Students will be able to design a control algorithm and to select an appropriate type of switch-mode power converter for a brushless motor drive. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Študenti bodo pridobili znanje za uspešno načrtovanje elektromotorskih pogonov , ki so sestavljeni iz elektronsko komutiranih električnih strojev in učinkovitih močnostnih polprevodniških pretvornikov. | | |  | Student will be able to design advanced electrical drives based on electronically commutated electric machines and high efficient power electronic converters. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja | | |  | Lectures | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Pisni izpit, projekt | **50/50** | | | | Written exam, individual project evaluation |
| **Reference nosilca / Lecturer's references:** | | | | | |
| [1] Flisar U, Vončina D, Zajec P (2012) Voltage sag independent operation of induction motor based on Z-source inverter. *Compel*, vol 31, no 6: 1931-1944  [2] Petkovšek M, Leban A, Nemec, M., Vončina D, Zajec P (2013) Series active power filter for high-voltage synchronous generators. *Informacije MIDEM*, vol. 43, no. 4: 228-234  [3] Kosmatin P, Miljavec D, Vončina D (2012) A novel control strategy for the switched reluctance generator. *Przeglęad Elektrotechniczny*, 2012, rok 88, no. 7a: 49-53  [4] Modrijan G, Petkovšek M, Zajec P, Vončina D (2008) Precision B-H analyser with low THD secondary induced voltage. *IEEE trans. ind. electron*, vol. 55, no. 1: 364-370  [5] Bajec P, Pevec B, Vončina D, Miljavec D, Nastran (2005) Extending the low-speed operation range of PM generator in automotive applications using novel AC-DC converter control. *IEEE trans. ind. electron*  vol. 52, no. 2: 436-443 | | | | | |