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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Električni servo sistemi | | | | | | | | | | | | | | |
| **Course title:** | | | Electric Servo 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 | | | | | Mehatronika | | | | | | | | 1 | | 2 | | |
| 2nd cycle masters study programme in Electrical Engineering | | | | | Mechatronics | | | | | | | | 1 | | 2 | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Obvezni-strokovni / Compulsory professional | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64231S | | | | | |
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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** |
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| **Nosilec predmeta / Lecturer:** | | | | | Vanja Ambrožič | | | | | | | | | | | | |
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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. | | | | | | | | |  | Enrolment in the year of the course. | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| Definicija servo pogonov, pomanjkljivosti klasičnih pristopov, napetostno/frekvenčno napajanje izmeničnih strojev. Krmiljenje pretvorniških vezij in modulacijske metode. Vektorski modeli izmeničnih strojev in primerjava z enosmernimi stroji, teorija orientacije polja, regulacija servo pogonov z asinhronskimi, sinhronskimi, elektronsko komutiranimi in reluktančnimi motorji. Najnovejše metode krmiljenja in regulacij izmeničnih strojev. Brezsenzorska regulacija. Diskretne regulacije in teorija multivariabilnih sistemov na področju servopogonov. Mikroprocesorski sistemi v servopogonih. | | | | | | | |  | | Definition of servo drives, deficiencies of classical approaches, voltage/frequency supplying of AC machines. Control of converters and modulation approaches. Vector models of AC machines in comparison to DC machines, Field orientation theory, control of servo drives with induction, synchronous, electronically commutated and reluctance motors. Modern methods for open- and closed-loop control. Sensorless control. Discrete control and theory of MIMO systems in the area of servo drives. Microprocessors in servo drives. | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. Ambrožič Vanja, Zajec Peter: »Električni servo pogoni«, Slovensko združenje elektroenergetikov CIGRÉ-CIRED, 2016. 2. Ambrožič Vanja: »Mikroračunalniki v močnostni elektroniki«, Fakulteta za elektrotehniko, Ljubljana, 2001 3. Leonhard W.: “Control of Electrical Drives”, Springer, Berlin, 2001 4. Bose B. K.: “Modern Power Electronics and AC Drives”, Prentice Hall, 2002 | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Spoznavanje servopogonov, ki so osnova sodobne mehatronike, kompleksnosti njihove regulacije, integiranja komponent in problematike izbire primernega motorja. | |  | | Getting to know servo drives, as basis for modern mechatronics, their complexity, and integration of components. Choosing the suitable motor. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| **Znanje in razumevanje**: Študent se bo seznanil z nalogami servo pogonov, možnostmi in problemi realizacije pri uporabi različnih strojev ter najsodobnejšimi regulacijskimi pristopi.  **Uporaba**: Konkretni izračuni in optimiziranja regulacijskih zank skozi primere različnih elektromotorskih pogonov. Modeliranje splošnih diskretnih in multidimenzionalnih sistemov.  **Refleksija**: Skozi simulacije in testiranja reguliranih pogonov bo možna primerjava med idealnimi, teoretičnimi modeli in industrijskimi pogoni v realnem, z motnjami obremenjenem okolju.  **Prenosljive spretnosti**: Uporaba informacijske tehnike: samostojno sestavljanje simulacijskih modelov reguliranih pogonov - Računske spretnosti: izračun in optimiziranje parametrov regulatorjev. | | |  | **Knowledge and understanding:**  The student will get acquainted with task performed by servo drives, possibilities and problems in its realization using different machines, and modern control techniques.  **Application:** Practical calculation and optimization of control loops through examples of different electrical drives. General modelling of discrete and multivariable systems.  **Reflection:** A comparison between ideal, theoretical, models and industrial drives in a real environment will be possible through simulations and testing.  **Transferable skills:** Use of information technologies: building up the simulation models of servo drives. Computational skills: calculation and optimization of control parameters. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja in obvezne laboratorijske vaje na simulacijskih in laboratorijskih modelih. | | |  | Lectures and mandatory laboratory exercises on simulation and experimental models. | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| 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 pisnem izpitu, pozitivna ocena pisnega izpita pa pogoj za opravljanje ustnega izpita.  Prispevki k oceni:   * laboratorijske vaje * pisni in ustni izpit | 50%  50% | | | | Negative grades: from 1 to 5, positive grades: from 6 to 10.  Positive evaluation of laboratory exercises is a prerequisite for the written exam; its positive evaluation is a prerequisite for the oral exam.  Contributions to the final grade:   * laboratory exercises * written and oral exam |
| **Reference nosilca / Lecturer's references:** | | | | | |
| 1. AMBROŽIČ, Vanja, ZAJEC, Peter. Električni servo pogoni. 1. izd. V Ljubljani: Slovensko združenje elektroenergetikov CIGRÉ-CIRED, 2016. ISBN 978-961-6265-27-0. [COBISS.SI-ID 283707392] 2. KONTARČEK, Andraž, BAJEC, Primož, NEMEC, Mitja, AMBROŽIČ, Vanja, NEDELJKOVIĆ, David. Cost-effective three-phase PMSM drive tolerant to open-phase fault. IEEE transactions on industrial electronics, ISSN 0278-0046. [Print ed.], Nov. 2015, vol. 62, no. 11, str. 6708-6718, ilustr., doi: 10.1109/TIE.2015.2437357. [COBISS.SI-ID 11176276] 3. DROBNIČ, Klemen, NEMEC, Mitja, FIŠER, Rastko, AMBROŽIČ, Vanja. Simplified detection of broken rotor bars in induction motors controlled in field reference frame. Control engineering practice, ISSN 0967-0661. [Print ed.], Aug. 2012, vol. 20, no. 8, str. 761-769, ilustr. [COBISS.SI-ID 9208660] 4. MAKUC, Danilo, DROBNIČ, Klemen, AMBROŽIČ, Vanja, MILJAVEC, Damijan, FIŠER, Rastko, NEMEC, Mitja. Parameters estimation of induction motor with faulty rotor. Przeglęad Elektrotechniczny, ISSN 0033-2097, 2012, rok 88, 1a, str. 41-46, ilustr. [COBISS.SI-ID 8870228] 5. NEMEC, Mitja, DROBNIČ, Klemen, NEDELJKOVIĆ, David, FIŠER, Rastko, AMBROŽIČ, Vanja. Detection of broken bars in induction motor through the analysis of supply voltage modulation. IEEE transactions on industrial electronics, ISSN 0278-0046. [Print ed.], Aug. 2010, vol. 57, no. 8, str. 2879-2888, ilustr. [COBISS.SI-ID 7819604] | | | | | |