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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Modeliranje električnih strojev | | | | | | | | | | | | | | |
| **Course title:** | | | Electrical Machines Modelling | | | | | | | | | | | | | | |
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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. | | zimski | | |
| 1st cycle academic study programme Electrical Engineering | | | | | **Power Engineering and Mechatronics** | | | | | | | | **3.** | | **winter** | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Obvezni- strokovni/compulsory professional | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64157 | | | | | |
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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:** | | | | | Damijan Miljavec | | | | | | | | | | | | |
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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):** | | | | | | | |
| Uporaba temeljnih elektromagnetnih zakonov v električnih strojih. Energija v magnetnem polju, sile in navor. Elektromagnetne lastnosti materialov uporabljenih v električnih strojih.  Analogija med magnetnimi krogi in električnimi vezji.  Elektromagnetni princip delovanja in zapisi veznih modelov transformatorjev, kolektorskih strojev, sinhronskih strojev, elektronsko komutiranih strojev in asinhronskih strojev na podlagi analogije med magnetnimi krogi in električnimi vezji. Analiza stacionarnih obratovalnih stanj obravnavanih strojev s pomočjo tako zapisanih veznih modelov.  Splošna vezna teorija električnih strojev in principi transformacij modelov.  Transformacije veznih modelov sinhronskih strojev, elektronsko komutiranih strojev in asinhronskih strojev v modele zapisane na podlagi splošne vezne teorije električnih strojev. Obravnavanje stacionarnih in prehodnih elektromehanskih stanj strojev zapisanih v okviru splošne vezne teorije električnih strojev.  Principi vodenja sinhronskih strojev, elektronsko komutiranih strojev in asinhronskih strojev. | | | | | | | |  | | The fundamental electromagnetic laws used in electrical machines. Energy in a magnetic fields, force and torque. The electromagnetic properties of materials used in electrical machines.  The analogy between magnetic circuits and electrical circuits.  Electromagnetic principles and definition of transformers circuit models, commutator machines models, synchronous machines models, electronically commutated machines models and induction machines models based on the analogy between magnetic circuits and electrical circuits. Steady state operation analysis of electric machine by means of circuit models.  Unified theory of electrical machinery and principles of models transformation.  Transformation of synchronous machine, electronically commutated machine and induction machine models in to the models developed on the basis of the unified theory of electrical machines. Addressing the steady state and transient conditions of analyzed electrical machines described within the unified theory of electrical machines.  Control principles of synchronous machines, electronically commutated machines and induction machines. | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. JEREB, Peter, MILJAVEC, Damijan. Vezna teorija električnih strojev. 1. izd. Ljubljana: Fakulteta za elektrotehniko, 2009.  2. Jacek F. Gieras, Advancements in Electric Machines, Springer, 2009.  3. Ion Boldea, Lucian Nicolae Tutelea, Electric Machines: Steady State, Transients, and Design with MATLAB, CRC Press, 2009.  4. P. S. Bimbhra: Generalized Theory of Electric Machinery, Khanna Publishers, Delhi, 2004.  5. Damijan Miljavec, Peter Jereb: Električni stroji – temeljna znanja, Ljubljana, 2009. | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Cilj predmeta je pridobiti poglobljena teoretična znanja in funkcionalno razumevanje delovanja električnih strojev. Usposobiti študenta za samostojno sintezo in analizo modelnih vezij električnih strojev ter z njihovo uporabo obravnavati stacionarna in prehodna elektromehanska stanja. Sposobnost določanja vrednosti elementov modelnih vezij na podlagi elektromehanskih preizkusov električnih strojev. Osvojena poglobljena znanja s področja teorije električnih strojev bodo omogočila načrtovanje električnih strojev, integracijo električnih strojev v krmilno regulacijske sisteme, uporabo električnih strojev v mehatronskih sistemih in sistemih za pretvorbo električne energije. | |  | | The aim of this course is to gain an in-depth theoretical and functional understanding of electric machines operation. To qualify the student for independent synthesis and analysis of electrical machines circuit models and to address stationary and transient electromagnetic states of electric machines. Ability to determine the values ​​of the elements of circuit models based on electromechanical testing of electrical machines. Conquered depth knowledge of the theory of electrical machines will enable the design of electrical machines, electrical machines integration in the control systems and the use of electrical machines in mechatronic systems and electric energy conversion. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Študent bo razumel temeljne principe delovanja električnih strojev. Njihova predstavitev v obliki modelnih vezij mu bo omogočila analizo stacionarnih in prehodnih elektromehanskih stanj. Študent pridobi sposobnost določanja parametrov modelnih vezij na podlagi elektro-mehanskih preizkusov električnih strojev. | | |  | The student will understand the fundamental principles of operation of electrical machines. Their presentation in the form of model circuits enables to analyse the steady state and transient electro-mechanical states. Students will acquire the ability to determine the parameters of model circuits on the basis of electro-mechanical tests of electrical machines. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja in laboratorijske vaje. Laboratorijske vaje so s povišano nevarnostjo (visoka napetost, vrteči se deli,...).  Predmet je sestavljen iz 45 ur predavanj in iz 30 ur laboratorijskih vaj s povišano nevarnostjo. | | |  | Lectures and laboratory work. As an option it is possible to include the students in the projects carried out in the Laboratory of electrical machines.  The course consists of 45 hours of lectures and 30 hours of laboratory exercises with heightened risk. | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| 1. Način: 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  ALI  2. Način: laboratorijske vaje, projekt.  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  projekt | 10%  45%  45%  10%  90% | | | | 1. 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  OR  2. Type: laboratory exercises, project.  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  project |
| **Reference nosilca / Lecturer's references:** | | | | | |
| 1. VUKOTIĆ, Mario, MILJAVEC, Damijan. Design of a permanent-magnet flux-modulated machine with a high torque density and high power factor. IET electric power applications, ISSN 1751-8660, 2016, vol. 10, iss. 1, str. 36-44.  2. VIDMAR, Gregor, MILJAVEC, Damijan. A universal high-frequency three-phase electric-motor model suitable for the delta and star winding connections. IEEE transactions on power electronics, ISSN 0885-8993, Aug. 2015, vol. 30, no. 8, str. 4365-4376.  3. VIDMAR, Gregor, MILJAVEC, Damijan, AGREŽ, Dušan. Measurement and evaluation of EDM bearing currents by the normalized Joule integral. Measurement science & technology, ISSN 0957-0233, 2014, vol. 25, no. 7, str. 1-10.  4. GOTOVAC, Gorazd, LAMPIČ, Gorazd, MILJAVEC, Damijan. Analytical model of permeance variation losses in permanent magnets of the multipole synchronous machine. IEEE transactions on magnetics, ISSN 0018-9464, Feb. 2013, vol. 49, no. 2, str. 921-928.  5. JEREB, Peter, MILJAVEC, Damijan. Vezna teorija električnih strojev. 1. izd. Ljubljana: Fakulteta za elektrotehniko, 2009. | | | | | |