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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | **Sodobni električni stroji** | | | | | | | | | | | | | | |
| **Coursetitle:** | | | Modern electrical machines | | | | | | | | | | | | | | |
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| **Študijski program in stopnja**  **Studyprogrammeandlevel** | | | | | **Študijska smer**  **Studyfield** | | | | | | | | **Letnik**  **Academicyear** | | **Semester**  **Semester** | | |
| doktorski študijski program tretje stopnje Elektrotehnika | | | | | Ni smeri | | | | | | | | 1 | |  | | |
| 3rd cycle: doctoral study programme Electrical Engineering | | | | |  | | | | | | | | **1** | |  | | |
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| **Vrsta predmeta / Coursetype** | | | | | | | | | | | | Izbirni/elective | | | | | |
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| **Univerzitetna koda predmeta / Universitycoursecode:** | | | | | | | | | | | | 64830 | | | | | |
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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:** | | | | | Damijan Miljavec | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | **Slovenščina/Slovenian** | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | **Slovenščina/Slovenian** | | | | | | | | | | | |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | | | | | | | | |  | **Prerequisits:** | | | | | | | |
| Vpis na 3. Stopnjo:na doktorski študij | | | | | | | | |  | Inscription in 3rd cycle: doctoral study | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| Pregled svetovnega razvoja novejših oblik električnih strojev. Vplivi lastnosti pogonskega sistema na izbiro in oblikovanje električnega stroja. Teoretična izhodišča delovanja sodobnih električnih strojev: izmeničnih enofaznih in poli-faznih, strojev s trajnimi magneti, elektronsko komutiranih in hibridnih električnih strojev. Energija in moč v vezju, ki popisuje elektromagnetno–mehanski sistem. Koncept splošnega modela stroja v lastnem koordinatnem sistemu, vezni model. Električne in mehanske enačbe stroja in njegovega veznega modela. Izbira in uporaba primernih transformacij spremenljivk oz. modelov. Metode vrednotenja, nelinearnosti modelov, časovne in prostorske harmonske komponente. Uporaba metode končnih elementov za modeliranje magnetnih in električnih stanj v električnih strojih. Optimizacijske metode pri oblikovanju električnih strojev. Opisovanje lastnosti magnetnih materialov z metodami umetne inteligence. Aplikacije numeričnih metod v reševanju veznih modelov električnih strojev. Sinteza pridobljenih znanj v konkretnih problemih načrtovanja sodobnih električnih strojev. | | | | | | | |  | | Overview of the global development of newer forms of electrical machines. Influence of drive system for selection and design of electric machine. The theoretical basis of modern electric machines: single and poly phase machines, permanent magnet machines, electronically commutated and hybrid machines. Energy and power in the circuit describing electromechanical system. The concept of a comprehensive model of the machine in its own coordinate system, circuit theory of electric machines. Electrical and mechanical equations of the machine and its circuit models. Selection and use of appropriate transformations of variables and models. Valuation methods, models nonlinearities, time and spatial harmonics. Using finite element method for modelling magnetic and electric conditions in electrical machines. Optimization methods in the design of electrical machines. Magnetic materials properties description with artificial intelligence methods. Application of numerical methods to solve the circuit models of electrical machines. The synthesis of acquired knowledge in concrete design of modern electrical machines. | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. Gieras F J (2009 ) Advancements in Electric Machines. Springer2. Umans S (2013) Electric Machinery. McGraw-Hill Science/Engineering/Math3. Bianchi N (2005) Electrical Machine Analysis Using Finite Elements. Power Electronics and Applications, Taylor and Francis Press 4. Boldea I, Tutelea L N (2009) Electric Machines: Steady State, Transients, and Design with MATLAB. CRC Press 5. Jereb P, Miljavec D (2009) Vezna teorija električnih strojev. Založba FE in FRI, Ljubljana | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Cilj predmeta je pridobiti poglobljena teoretična znanja in funkcionalno razumevanje delovanja sodobnih električnih strojev. Usposobiti študenta za samostojno oblikovanje modernih električnih strojev. Analitično in numerično obravnavati stacionarna in prehodna elektromagnetna ter elektromehanska stanja.Študent bo pridobil teoretična znanja potrebna za uporabo metode končnih elementov pri modeliranju magnetnih in električnih stanj v električnih strojih. Razumel bo optimizacijske metode pri oblikovanju električnih strojev. Pridobil bo sposobnost kritičnega vrednotenja dobljenih rezultatov. Osvojena poglobljena znanja s področja teorije električnih strojev bodo omogočila načrtovanje novih sodobnih električnih strojev in njihovo integracijo v modernepogonske sisteme. Implementacija sodobnih električnih strojev v sisteme za pretvorbo električne energije. | |  | | The aim of this course is to gain an in-depth theoretical and functional understanding of the operation of modern electric machines. To qualify the student for independent design of modern electrical machines. Analytical and numericaltreated stationary and transient electromagnetic and electromechanical states. Students will gaintheoretical knowledgerequiredto understandfinite element methodsfor modeling ofmagnetic and electricconditions inelectricalmachines. Also, understandingtheoptimization methodsin the design ofelectrical machines. Ability to critically assess the obtained results. Conquered depth knowledge of the theory of electrical machines will enable the design of new modern electrical machines, their integration into modern drive systems. Further implementation of modern electrical machines into electrical energy conversion systems. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Študent bo poglobljeno razumel principe delovanja električnih strojev. Obvladal bo modeliranje sodobnih oblik električnih strojev z metodo končnih elementov in njihovo predstavitev v obliki modelnih vezij. Vse to mu bo omogočilo analizo stacionarnih in prehodnih elektromagnetnih in elektromehanskih stanj. Študent bo pridobil kritično sposobnost vrednotenja dobljenih rezultatov in samostojnost pri oblikovanju novih sodobnih električnih strojev. | | |  | Student will in-depth understand the principles of electrical machines operation. Mastered the modelling of modern forms of electric machines using finite element method and their presentation in the form of circuit model. All of this will allow the analysis of stationary and transient electromagnetic and electromechanical conditions. Students will gain ability to critically evaluate obtained results and autonomy in the design of new modern electric machines. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja (v primeru večjega števila študentov) in projektna naloga. | | |  | Lectures (in the case of a large number of students) and project work. | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Študenti, vključeni v projektno delo, ki so nalogo uspešno zaključili in ustno zagovarjali, so s tem opravili izpit.Ocena se jim oblikuje na podlagi kvalitete opravljene naloge ter osvojenega znanja. | -Kvaliteta opravljene naloge 50%  -osvojeno znanje 50%.  -Quality of completed work 50%  -Obtained knowledge 50% | | | | Students involved in project work that have successfully completed and orally defended have passed the exam. The grade will be formed on the basis of the quality of completed work and also on obtained knowledge. |
| **Reference nosilca / Lecturer's references:** | | | | | |
| Vidmar G, Miljavec D (2015) A universal high-frequency three-phase electric-motor model suitable for the delta and star winding connections. IEEE transactions on power electronics 30:4365-4376  Vidmar G, Miljavec D, AGREŽ D (2014) Measurement and evaluation of EDM bearing currents by the normalized Joule integral. Measurement science & technology 25:7:1-10  Šrekl M, Bratina B, Zagirnyak M, Benedičič B, Miljavec D (2013) Losses in the axial-flux permanent-magnet machine housing. Compel 32:4:1366-1382  Gotovac G, Lampič G, Miljavec D (2013) Analytical model of permeance variation losses in permanent magnets of the multipole synchronous machine. IEEE transactions on magnetics49:2:921-928  Stojčić B, Miljavec D (2012) Current distribution in the low-voltage winding of the furnace transformer. International journal of electrical power & energy systems 43:1:1251-1258 | | | | | |