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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Senzorji in merilni pretvorniki | | | | | | | | | | | | | | |
| **Course title:** | | | Sensors and Measurement Transducers | | | | | | | | | | | | | | |
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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 | | | | | | | | 2 | | 1 | | |
| 2nd cycle masters study programme in Electrical Engineering | | | | | Mechatronics | | | | | | | | 2 | | 1 | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Obvezni-strokovni / Compulsory professional | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64293 | | | | | |
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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 |
|  | | | | | | | | | | | | | | | | | |
| **Nosilec predmeta / Lecturer:** | | | | | Peter Zajec | | | | | | | | | | | | |
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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 predmeta | | | | | | | | |  | Enrolment in the year of the course | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| a) Osnove in pomen senzorjev v močnostni elektrotehniki ter meritve neelektričnih veličin v mehatronskih sistemih.  b) Pretvorniki merilnih veličin: osnovni pojmi in definicije, merilna veriga in definicija njenih sestavnih delov, idealni/realni merilni člen, statična karakteristika, dinamične lastnosti, vplivne veličine, zanesljivost in varnost.  c) Fizikalni opis termično-električne pretvorbe, optično-električne, mehanično-električne, magnetno-električne, kemijsko-električne pretvorbe in ostalih geometrijsko snovnih sprememb, ki se jih izkorišča v sodobnim merilnih členih.  d) Meritve mehanskih in procesnih veličin za aplikacije v pogonskih sistemih in mehanskih konstrukcijah. Merjenje:  -geometričnih veličin kot so: raztezek, linearni premik, kot zasuka, število vrtljajev in kotna hitrost, debelina plasti,  -sile, tlaka (tekočinski in mehanski merilniki, z uporovnim trakom, induktivni, kapacitivni senzor) in vrtilnega momenta in moči,  -mase,  -volumskega in masnega pretoka fluidov in sipkih materialov,  -temperature (termistorji, Pt uporovni senzorji, termočlen, polprevodniški senzorji),  -kemijskih ter snovnih lastnosti,  -končna stikala.  e) Problemi galvansko ločene meritve toka in napetosti za regulacijsko tehnične namene.  f) Prilagodilna vezja, elektronsko ovrednotenje signalov iz merilnikov napetosti, toka, položaja, hitrosti in pospeška. Zgradba sodobnih merilnih sistemov, uporaba virtualnih instrumentov. | | | | | | | |  | | a) To emphasize the significance of sensors in power engineering and measurement transducers in mechatronic systems.  b) Transducers: basic concepts and definitions, measuring chain and the definition of its components, ideal / real measurement transducer, the static characteristics, dynamic characteristics, influence quantity, reliability and security.  c) Physical description of thermal-electrical conversion, optical-electrical, mechanical-electrical, magnetic-electric, chemical-electrical conversion and other geometric material changes being exploited in modern measuring articles.  d) Measurement of mechanical and process variables for applications in propulsion systems and mechanical structures. Measurement:  -geometrical quantities such as: expansion, linear displacement, a rotation angle, speed and angular speed, the thickness of layers,  -force, pressure (liquid and mechanical gauges with resistance band, inductive, capacitive sensor) and the torque and power,  -mass,  -volumetric and mass flow of fluids and sandy materials,  -temperature (thermistors, resistance Pt sensors, thermocouple, semiconductor sensors)  -chemical and other properties of material,  -proximity switches.  e) Galvanic separation of measuring circuits in the field of control electronics.  f) Matching circuits, electronic evaluation of signals from voltage, current, position, velocity and acceleration gauges. Structure of modern measuring systems, the use of virtual instruments. | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. D. Fefer, A. Jeglič: Senzorji in pretvorniki, Univerza v Ljubljani, Fakulteta za elektrotehniko, 2006. 2. P.Zajec, zapiski predavanj 3. J. Turner, Automotive Sensors. Momentum Press, 2009. 4. E. Ramsden, Hall-Effect Sensors: Theory and Application. Newnes, 2011. 5. P. P. L. Regtien, Sensors for Mechatronics. Elsevier, 2012. 6. R.Pallás-Areny, J.G.Webster: Sensors and signal conditioning, New York, Wiley, 2001. 7. H. Bernstein: Sensoren und Messelektronik, München, Pflaum, 1998. | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Cilj je oblikovanje kompetentnega znanja za optimalno izbiro senzorjev ter zasnovo in oceno lastnosti merilnika neelektričnih in električnih veličin. | |  | | To establish competent background in the field of sensoric: to be familiar with selection, design and evaluation of different sensors capable of measuring diverse (non)electrical quantities. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Osvojitev znanj o merilnih senzorjih in pretvornikih fizikalnih veličin v motorskih pogonih, regulacijski tehniki in močnostni elektroniki. | | |  | To gain knowledge on sensors, transducers and signal conditioning of physical quantities usually found in electric motor drives, control and power electronics. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja s sprotnim avditornim utrjevanjem snovi na primeru računskih nalog. Praktično utrjevanje snovi na laboratorijskih vajah. | | |  | Lectures with a number of practical tutorial examples. Laboratory work for practical verification of lecture material. | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| 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 | 20%  40%  40% | | | | 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 |
| **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, 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. RUPAR, Uroš, LAHAJNAR, Franci, ZAJEC, Peter. Iterative-learning-based torque-ripple compensation in a transverse flux motor, IET control theory & applications, ISSN 1751-8644, 2012, vol. 6, no. 3, str. 341-348. 4. PETKOVŠEK, Marko, KOSMATIN, Peter, ZEVNIK, Ciril, VONČINA, Danijel, ZAJEC, Peter. Measurement system for testing of bipolar plates for PEM electrolyzers, Informacije MIDEM, ISSN 0352-9045, mar. 2012, letn. 42, št. 1, str. 60-67. 5. OSTROŽNIK, Simon, BAJEC, Primož, ZAJEC, Peter. A study of a hybrid filter, IEEE transactions on industrial electronics, ISSN 0278-0046, Mar. 2010, vol. 57, no. 3, str. 935-942. | | | | | |