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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Senzorji in aktuatorji | | | | | | | | | | | | | | |
| **Course title:** | | | Sensors and actuators | | | | | | | | | | | | | | |
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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:** | | | | | | | | | | | | 64811 | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| **45** | **30** | | |  | | |  | | | |  | | | **50** | |  | **5** |
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| **Nosilec predmeta / Lecturer:** | | | | | doc. dr. Matej Možek | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | SLOVENSKI | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | |  | | | | | | | | | | | |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | | | | | | | | |  | **Prerequisits:** | | | | | | | |
| Vpis v 1. letnik doktorskega študija | | | | | | | | |  | Enrolment in the 1st year of doctoral study programme | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| Definicije senzorjev, osnovni principi pretvorbe, klasifikacije senzorjev in aktuatorjev. Osnovni senzorski parametri: karakteristika, točnost, ločljivost, občutljivost, selektivnost, minimalni detektirani signal, prag, nelinearnost, histereza, ponovljivost, šum, temperaturni ničelni odziv, preobremenitev, zakasnitev odziva, stabilnost, analiza časovnega odziva senzorja  Senzorske tehnologije: mikro-obdelava, lastnosti osnovnih materialov, depozicije tankih plasti, fotolitografija, jedkanje, LIGA, žrtvovani film, laserska obdelava, zatesnitev odprtin, spajanje substratov, izdelava 3D struktur, montaža in zapiranje v ohišje,  Analogna in digitalna obdelava signalov senzorskih in aktuatorskih signalov.  Pregled senzorskih in aktuatorskih družin ter njihovih aplikacij: Piezorezistivni, Piezoelektrični, Piroelektrični, Kapacitivni, Resonančni, Termoelektrični , Radiacijski, Magnetni, Kemijski, Senzorji na osnovi optičnih vlaken.  Napredne senzorske in aktuatorske strukture. | | | | | | | |  | | Sensor definitions, transduction principles, classifications of sensors and actuators.  Essential sensor properties: characteristics, sensitivity, accuracy, resolution, selectivity, minimal detected signal, threshold, nonlinearity, repeatability, noise, temperature zero drift, overload, stability, analysis of sensor dynamic response  Review of standard silicon microelectronic technologies: Micromachining: basic materials properties, deposition, etching, LIGA, sacrified film, laser application, opening sealing, substrate bonding, sensor chip encapsulation/packaging, 3D structures fabrication  Analog and digital signal conditioning in sensor and actuator systems-.  Review of sensor and actuator structures and applications: Piezoresistive, Piezoelectric, Pyroelectric, Capacitive, Resonant, Thermoelectric, Radiation, Magnetic, Chemical, Optical fiber  Advanced sensor and actuator structures, | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| Lyshevski S (2005) Nano- and microelectromechanical systems, CRC press, Boca Raton  Fraden J (2010) Handbook of modern sensors : physics, designs, and applications, Springer, New York  Horowitz P, Hill W (2008) The art of electronics, Cambridge University Press, Cambridge  Soloman S (2010) Sensors handbook, McGraw-Hill, New York  Amon, Slavko (2013) Senzorji in aktuatorji, Fakulteta za elektrotehniko, Ljubljana | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Poznavanje principov delovanja, struktur, tehnologij in aplikacij senzorjev in aktuatorjev.  Uporaba pridobljenega znanja o senzorjih in aktuatorjih pri realizaciji naprednih senzorskih in aktuatorskih sistemov. | |  | | Understanding of effects, structures, technologies and applications of sensors and actuators.  Application of obtained sensor and actuator knowledge for realization of advanced sensor and actuator systems. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Predstaviti principe delovanja, struktur, tehnologij in aplikacij senzorjev in aktuatorjev in jih njihovo uporabo pri reševanju praktičnih problemov v senzorskih in aktuatorskih sistemih. | | |  | Presentation of effects, structures, technologies and applications of sensors and actuators, and their application in practical problems in advanced sensor and actuator systems. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja, seminar | | |  | Lectures, seminar | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Način (seminar, ustni zagovor):   Končna ocena je sestavljena iz povprečne ocene, ki jo sestavlja:  ocena seminarske naloge in  ocena ustnega zagovora. | **50 50** | | | | Type (Seminar, oral examination):    Final exam grade is an average of: seminar work grade and  oral examination grade. |
| **Reference nosilca / Lecturer's references:** | | | | | |
| Možek M, Vrtačnik D, Resnik D, Pečar B, Amon S (2011) Adaptive calibration and quality control of smart sensors. In: Ivanov O (ed) Applications and experiences of qulity control, Intech, Rijeka: pp 645-662  Pečar B, Križaj D, Vrtačnik D, Resnik D, Dolžan T, Možek M (2014) Piezoelectric peristaltic micropump with a single actuator. Journal of micromechanics and microengineering: 24/10: 1-9  Dolžan T, Pečar B, Možek M, Resnik D, Vrtačnik D (2015) Self-priming bubble tolerant microcylinder pump. Sensors and actuators. A, Physical 233: 548-556  Resnik D, Možek M, Pečar B, Dolžan T, Janež A, Urbančič-Rovan V, Vrtačnik D (2015) Characterization of skin penetration efficacy by Au-coated Si microneedle array electrode. Sensors and actuators. A, Physical 232: 299-309  Pečar B, Vrtačnik D, Resnik D, Možek M, Dolžan T, Brajkovič R, Križaj D (2015) Micropump operation at various driving signals : numerical simulation and experimental verification. Microsystem technologies 21/7: 1379-1384 | | | | | |