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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Metrologija in kakovost sistemov | | | | | | | | | | | | | | |
| **Course title:** | | | Metology and Quality Systems | | | | | | | | | | | | | | |
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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:** | | | | | | | | | | | | 64820 | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| **30** | **60** | | |  | | |  | | | | **10** | | | **25** | |  | **5** |
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| **Nosilec predmeta / Lecturer:** | | | | | prof. dr. Janko Drnovšek | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | **Slovenščina/Angleščina** | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | |  | | | | | | | | | | | |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | | | | | | | | |  | **Prerequisits:** | | | | | | | |
| Vpis v letnik | | | | | | | | |  | Enrolment in the Doctoral study programme in Electrical Engineering (3rd cycle) | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| Mednarodna standardizacija in kompatibilnost proizvodov, storitev in procesov za regulirano in neregulirano področje: osnovni principi metroloških sistemov in standardizacije, organizacija akreditacijske službe, sistemi certificiranja, pregled evropske tehniške zakonodaje, kontrola in analiza delujočih sistemov kakovosti, ISO in EN standardi, osnovna znanja s področja priprave laboratorijev. Razvoj, fizikalne osnove in realizacija osnovnih SI enot, fizikalne konstante, hierarhična organizacija metroloških sistemov, mednarodna kompatibilnost, razvoj metrologije, elementi formalne teorije merjenj, simbolična reprezentacija, informacijska vsebina, teorija merjenj, analiza merilnih pogreškov in merilne negotovosti, klasifikacija  pogreškov, kalibracija, etaloni, osnove kvantne metrologije, referenčni materiali, procesiranje in vrednotenje merilnih rezultatov, preskušanje, umerjanje, parametri merilnih sistemov. Kontrola kakovosti, zagotavljanje kakovosti, celovito zagotavljanje kakovosti, cena kakovosti, cena ne-kakovosti, organizacijska znanja, poslovne funkcije in procesi, vodenje upravljanja, odločanje, koordinacija, sistemi in tehnike planiranja, informacijski sistemi za kakovost, kakovost proizvodov in storitev. Spoznavanje modernih tehnik zagotavljanja kakovosti s primeri medlaboratorijskih primerjav, ocen tveganja pri analizi preskusnih postopkov in pripravi optimalnega eksperimenta. Postopek sprejemanja novih standardov na področju medicinske instrumentacije (postopki, klinične validacije, analiza tveganja).  Stacionarni prenos toplote in toplotna bilanca, načini prenosa toplote (prevajanje, konvekcija, sevanje), prenos toplote skozi stene (planparalelne, cilindrične), temperatura in temperaturne lestvice (realizacija in diseminacija), vrste termometrov (uporovni, termočleni, tekočinski, sevalni, termovizijske kamere), energetska učinkovitost zgradb (zasnova, izolacija, prezračevanje, ogrevanje, hlajenje, izračun, merjenje, energetska izkaznica). | | | | | | | |  | | International standardization and compatibility of products, services and processes for regulated and voluntary field: basic principles of metrology systems and standardization, organization of the accreditation organization, certification systems, review of European technical legislation, control and analyses of active quality systems, ISO and EN standards, basic knowledge on preparation of laboratories. Development and realization of basic SI units, physical constants, hierarchical organisation of metrology systems, international compatibility, metrology development, elements of formal measurement theory, symbolical representation, information contents, measurement theory, measurement error and measurement uncertainty analyses, classification of errors, calibration, etalons, basic of quantum metrology, reference materials, processing and evaluation of measurement results, testing, calibration, measurement system parameters. Quality control, quality assurance, total quality assurance, quality costs, bad quality costs, organizational knowledge, business functions and processes, administration management, decision-making, coordination, systems and planning techniques, quality information systems, products and services quality. Become aware of modern quality assurance techniques with examples of interlaboratory comparisons, risk assessment in testing procedure evaluation and preparation of optimal experiment. The process of adopting new standards in the field of medical instrumentation (procedures, clinical validation, risk analysis).  steady state heat transfer and heat balance,  heat transfer (conduction, convection, radiation), heat transfer through walls (planparallel, cylindric), temperature and temperature scales (realization and dissemination), thermometers (resistance, thermocouples, liquid-in-glass, radiation, thermal imagers), energy efficiency of buildings (design, insulation, ventilation, heating, cooling, calculation, measurement, energy certificate) | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| [1] Pham D T, Oztemel E (1996) Intelligent Quality Systems. Springer-Verlag, Berlin  [2] Montgomery D C (2001) Introduction to Statistical Quality Control, 4. th edn. John Wiley & Sons Inc, New York  [3] Marlow A J (2005) Quality control for Technical Documentation, Amazon  [4] Regtien P P L (2004) Measurement Science for Engineers. Sterling: Kogan Page Science, London  [5] www.sist.si, www.iso.org, www.iec.ch, www.iecee.org, www.cenelec.org, www.itu.int, www.cenorm.be, www.gov.si/sa, www.ilac.org, www.mirs.si, www.euramet.eu, www.wto.org, www.ansi.org, http://ts.nist.gov, www.conformityassessment.org, www.wssn.net, www.oiml.org, www.asq.org, http://ec.europa.eu/enterprise/newapproach/ | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| Cilj predmeta je seznaniti in usposobiti kandidate z znanji o doseganju celovite kakovosti sistemov, od presoje in certificiranja sistemov, obravnavanje tehniške kakovosti, in spoznavanja orodij za doseganje uspehov. Študent pridobi znanje o metrologiji fizikalnih, kemijskih in fizioloških veličin, o principih in prevladujočih tehniških praksah pri merjenju in analizi rezultatov in merilnih negotovosti. Kandidat se spozna tudi z zanesljivostjo, varnostjo, gospodarnostjo in energetsko učinkovitostjo, zakonodajo in okoljsko problematiko vezano na kakovost. | |  | | The goal of the course is to inform and qualify candidates with knowledge of total quality management, from assesment througt certification of quality sistems, dealing with technical quality and become aware of tools for attaining success. Student gain knowledge on metrology of physical, chemical and physiological quantities, principles and prevailing techical practices in measurement and measurement uncertainty and measurement result analises. Candidate become aware of reliability, safety, economy and energy efficiency, legislation and environment problematics related to quality. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| Znanje in razumevanje:  - osnovni pojmi s področja tehniške infrastrukture;  - konkretno tehniško znanje na področju preskušanja, poznavanje laboratorijskega dela za zagotavljanje kakovosti in varnosti, priprava optimalnega eksperimenta;  - znanje o vzpostavitvi in celovitem vodenju sistemov kakovosti;  - povezanost kakovosti na pravo, varnost in okolje na različnih tehniških področjih, medicini in psihoanalizi; | | |  | Knowledge and understanding:  - basic concept of technical infrastructure;  - concrete technical knowledge on testing, laboratory work on quality assurance and product safety, preparation of optimal experiment;  - knowledge on implementation of quality system and total quality management;  - relation of quality and law, safety and environment on different technical, medical and psychological fields; | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| Predavanja s praktičnimi primeri, seminar, samostojno delo | | |  | Lectures with practical examples, seminar, individual work | |
| **Načini ocenjevanja:** | Delež (v %) /  Weight (in %) | | | | **Assessment:** |
| Način:  Ustno izpraševanje,  projekti | 50 %  50 % | | | | Type:  Oral exam,  projects |
| **Reference nosilca / Lecturer's references:** | | | | | |
| Begeš G, Dalsgaadr J H, Drnovsek J (2008) Information extraction from interlaboratory comparison in testing - temperature measurement in the black test corner. J test eval, 36, no. 4: 345-355  Drnovšek J (2008) On the specific experience of national metrology institutes (NMIs) with national accreditation bodies (NABs). Accreditation and Quality Assurance, Journal for Quality, Comparability and Reliability in Chemical Measurement 769:0949-1775  Pusnik I, Drnovšek J (2005) Infrared ear thermometers - parameters influencing their reading and accuracy. Physiol meas 26:1075-1084  Begeš G, Drnovšek J, Pendrill L R (2010) Optimising calibration and measurement capabilities in terms of economics in conformity assessment. Accreditation and quality assurance 15 no. 3:147-154  Geršak G, Žemva A, Drnovšek J (2009) A procedure for evaluation of non-invasive blood pressure simulators. Medical & biological engineering & computing 47, no. 12:1221-1228 | | | | | |