

EKSPERIMENTALNE METODE V RAZISKOVALNEM DELU

UČNI NAČRT PREDMETA/COURSE SYLLABUS

Predmet:	EKSPERIMENTALNE METODE V RAZISKOVALNEM DELU
Course title:	EXPERIMENTAL METHODS IN RESEARCH WORK
Članica nosilka/UL Member:	UL FS

Študijski programi in stopnja	Študijska smer	Letnik	Semestri	Izbirnost
Strojništvo, tretja stopnja, doktorski	Ni členitve (študijski program)	1. letnik, 2. letnik	Celoletni	izbirni

Univerzitetna koda predmeta/University course code: 0033412

Koda učne enote na članici/UL Member course code: 7003

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorial s	Klinične vaje /Clinical tutorials	Druge oblike študija /Other forms of study	Samostojno delo /Individual student work	ECTS
90					160	10

Nosilec predmeta/Lecturer: Drago Bračun, Jože Kutin

Izvajalci predavanj: Drago Bračun, Jože Kutin

Izvajalci seminarjev:

Izvajalci vaj:

Izvajalci kliničnih vaj:

Izvajalci drugih oblik:

Izvajalci praktičnega usposabljanja:

Vrsta predmeta/Course type:

Izbirni predmet /Elective course

Jeziki/Languages:

Predavanja/Lectures:

Angleščina, Slovenščina

Vaje/Tutorial:

Angleščina, Slovenščina

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:**Prerequisites:**

Veljajo splošni pogoji za doktorski študij.

General prerequisites for the third level studies.

Vsebina:**Content (Syllabus outline):**

Zgradba in funkcijski opis merilnih sistemov. Temeljni elementi merilnih sistemov. Delovne značilnice instrumentov. Manipulacija, prenos in zapis merjenih vrednosti. Sistemi za zapis in prikaz merjenih vrednosti. Veliki sistemi za zajemanje in vrednotenje merjenih vrednosti. Avtomatizacija eksperimentalnega dela. Pristop k eksperimentalnemu delu. Metode in pomen načrtovanja preizkusov. Metrološka analiza izmerjenih vrednosti in prikaz rezultatov.

Structure and functional description of measurement systems. Basic elements of measurement systems. Working characteristics of instruments. Manipulation, transfer and record of measured quantities. Systems for recording and displaying measurement quantities. Large systems for acquisition and evaluation of measurement quantities. Automatisation of experimental work. Approach to experimental work. Methods and importance of experiment planning. Metrological analysis of measured quantities and display of results.

Temeljna literatura in viri/Readings:

- [1] Montgomery, D.C.: Design and analysis of experiments. Wiley, 2009 [COBISS.SI-ID 11603483]
 [2] Myers, R. H., Montgomery, D. C., Anderson-Cook, C. M.: Response surface methodology: process and product optimization using designed experiments. Wiley, 2009 [COBISS.SI-ID 11604251]
 [3] Holman, J.P.: Experimental methods for engineers. McGraw-Hill, 2001 [COBISS.SI-ID 4627739]
 [4] Kirkup, L., Frenkel, R. B.: An introduction to uncertainty in measurement using the GUM. Cambridge University Press, 2006 [COBISS.SI-ID 666619]
 [5] Slaev, V. A., Chunovkina, A. G., Mironovsky, L. A.: Metrology and theory of measurement. De Gruyter, 2013 [COBISS.SI-ID 13148955]
 [6] Figliola, R. S., Beasley, D. E.: Theory and design for mechanical measurements. Wiley, 2011 [COBISS.SI-ID 35307013]
 [7] Morris, A. S.: Measurement & instrumentation principles. Butterworth-Heinemann, 2001 [COBISS.SI-ID 2266708]
 [8] Hashemian, H. M.: Sensor performance and reliability. ISA, 2005 [COBISS.SI-ID 10583323]
 [9] Montgomery, D. C., Runger, G. C.: Applied statistics and probability for

Cilji in kompetence:

Cilji:

Vsebina učnega predmeta je usmerjena k razumevanju vloge in ciljev eksperimentalnih metod v raziskovalnem delu in k sistemskemu pristopu h gradnji, strukturiranju in meroslovno korektni uporabi merilnih sistemov v raziskovanju. V učnem predmetu je vključeno tudi načrtovanje eksperimentalnega dela predvsem na temelju metod statističnega načrtovanja preizkusov.

Kompetence:

Študent osvoji pristop k načrtovanju in izvedbi eksperimentalnega dela v raziskovanju s poudarkom na sistemskemu načrtovanju in analizi rezultatov.

Objectives and competences:

Goals:

Contents of the course is oriented to understanding the role and goals of experimental methods in experimental work and understanding the systematic approach in construction, structuring and metrological correct use of measurement systems in research work. The course includes planning of the experimental work, especially based on methods of statistical planning of experiments.

Competence:

A student will acquire knowledge how to approach and conduct the experiment in research work with emphasis on systematic planning and analysis of results.

Predvideni študijski rezultati:

Študent osvoji pristop k načrtovanju in izvedbi eksperimentalnega dela v raziskovanju s poudarkom na sistemskemu načrtovanju in analizi rezultatov.

Intended learning outcomes:

A student will acquire knowledge how to approach and conduct the experiment in research work with emphasis on systematic planning and analysis of results.

Metode poučevanja in učenja:

Predavanja, laboratorijske vaje, seminarsko delo, e-izobraževanje, konzultacije. Seminarsko delo v čim večji meri navezuje se na področje doktorskega raziskovanja. Študij z uporabo priporočene literature.

Learning and teaching methods:

Lectures, laboratory practice & seminar work, e-education, consulting. The seminar work is related, as much as possible, to the student's doctoral research field. Study on a recommended literature basis.

Načini ocenjevanja:

Način (pisni izpit, ustno izpraševanje, naloge, projekt) - naloge (20%), - projektni seminar (60%), - ustno izpraševanje in zagovor (20%).

Delež/Weight

Assessment:

Method (written exam, oral examination, assignments, project) • assignments (20%) • project seminar (60%) • oral

Ocenjevalna lestvica:**Grading system:****Reference nosilca/Lecturer's references:****izr. prof. dr. Jože Kutin**

KUTIN. Jože, BOBOVNIK, Gregor, BAJSIC, Ivan. Dynamic effects in a clearance-sealed piston prover for gas flow measurements. *Metologia* 48 (2011) 123-132.

RUPNIK, Klemen, KUTIN. Jože, BAJSIC, Ivan. Identification and prediction of the dynamic properties of resistance temperature sensors. *Sensors and Actuators. A, Physical* 197 (2013) 69-75. IF(2013) : 1.943

KUTIN. Jože, BOBOVNIK, Gregor, BAJSIC, Ivan. Heat exchange effects on the performance of a clearance-sealed piston prover for gas flow measurements. *Metologia* 52 (2015) 857-863. IF(2015) : 2.5

SVETE, Andrej, KUTIN. Jože, BOBOVNIK, Gregor, BAJSIC, Ivan. Theoretical and experimental investigations of flow pulsation effects in Coriolis mass flowmeters. *Journal of Sound and Vibration* 352 (2015) 30-45. IF(2015) = 2.107

SVETE, Andrej, STEFE, Metka, MACEK, Andraž, KUTIN. Jože, BAJSIC, Ivan. Dynamic pressure generator for dynamic calibrations at different average pressures based on a double-acting pneumatic actuator. *Sensors and actuators. A, Physical* 247 (2016) 136-143. IF(2016) = 2.201

BOBOVNIK, Gregor, KUTIN. Jože, BAJSIC, Ivan. Uncertainty analysis of gas flow measurements using clearance-sealed piston provers in the range from 0.00129 l/min to 609 l/min. *Metologia* 53 (2016) 1061-1068. IF(2016) = 2.5

doc. dr. Drago BRAČUN

BUDAK, Igor, VUKELIĆ, Djordje, BRAČUN, Drago, HODOLIČ, Janko, SOKOVIĆ, Mirko. Pre-processing of point-data from contact and optical 3D digitization sensors. *Sensors*. 2012, vol. 12, no. 1, str. 1100-1126. ISSN 1424-8220. [COBISS.SI-ID 12177691]

ŠČETINEC, Aljaž, KLOBČAR, Damjan, BRAČUN, Drago. In-process path replanning and online layer height control through deposition arc current for gas metal arc based additive manufacturing. *Journal of manufacturing processes*. Apr. 2021, vol. 64, str. 1169-1179, [COBISS.SI-ID 54240259]

KOZAMERNIK, Nejc, ZALETELJ, Janez, KOŠIR, Andrej, ŠULIGOJ, Filip, BRAČUN, Drago. Visual quality and safety monitoring system for human-robot cooperation. *International journal of advanced manufacturing technology*. Jul. 2023, str. 1-17, [COBISS.SI-ID 159531011]

ŠČETINEC, Aljaž, KLOBČAR, Damjan, BRAČUN, Drago. In-process path replanning and online layer height control through deposition arc current for gas metal arc based additive manufacturing. *Journal of manufacturing processes*. [Print ed.]. Apr.

2021, vol. 64, str. 1169-1179,[COBISS.SI-ID 54240259]

KOZAMERNIK, Nejc, BRAČUN, Drago, KLOBČAR, Damjan. WAAM system with interpass temperature control and forced cooling for near-net-shape printing of small metal components. International journal of advanced manufacturing technology. Sep. 2020, vol. 110, iss. 7/8, str. 1955-1968, [COBISS.SI-ID 27509507]