

# EKSPERIMENTALNE METODE V RAZISKOVALNEM DELU

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

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

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

**Univerzitetna koda predmeta/University course code:** 0033412

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

Predavanja /Lectures	Seminar /Seminar	Vaje /Tutorials	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.- 5th ed., J. Wiley, 2001.

[2] Barney, George C.: Intelligent instrumentation: microprocessor applications in measurement and control.- 2nd ed.- New York: Prentice Hall, 1988

[3] Holman, J.P.: Experimental methods for engineers.- 7th ed.- Boston etc.: McGraw-Hill, cop. 2001.- (McGraw-Hill series in mechanical engineering).

[4] Boyes, W.: Instrumentation Reference Book, 3rd ed., Elsevier, 2003.

[5] Dietrich, C.F.: Uncertainty, calibration and probability: the statistics of scientific and

industrial measurement.- 2nd ed.- Bristol etc.: Adam Hilger, 1991.

**Cilji in kompetence:**

**Objectives and competences:**

**Cilji:**

**Goals:**

<p>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.</p> <p><b>Kompetence:</b></p> <p>Študent osvoji pristop k načrtovanju in izvedbi eksperimentalnega dela v raziskovanju s poudarkom na sistemskemu načrtovanju in analizi rezultatov.</p>	<p>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.</p> <p><b>Competence:</b></p> <p>A student will acquire knowledge how to approach and conduct the experiment in research work with emphasis on systematic planning and analysis of results.</p>
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<b>Predvideni študijski rezultati:</b>	<b>Intended learning outcomes:</b>
Študent osvoji pristop k načrtovanju in izvedbi eksperimentalnega dela v raziskovanju s poudarkom na sistemskemu načrtovanju in analizi rezultatov.	A student will acquire knowledge how to approach and conduct the experiment in research work with emphasis on systematic planning and analysis of results.

<b>Metode poučevanja in učenja:</b>	<b>Learning and teaching methods:</b>
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.	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.

<b>Načini ocenjevanja:</b>	<b>Delež/ Weight</b>	<b>Assessment:</b>
Način (pisni izpit, ustno izpraševanje, naloge, projekt) - naloge (20%), - projektni seminar (60%), - ustno izpraševanje in zagovor (20%).		Method (written exam, oral examination, assignments, project) • assignments (20%) • project seminar (60%) • oral examination (20%)

<b>Reference nosilca/Lecturer's references:</b>
<p><b>izr. prof. dr. Jože KUTIN</b></p> <p>KUTIN. Jože, SMRECNİK, Andrej, BAJSIC, Ivan. Phase-locking control of the Coriolis meter's resonance frequency based on virtual instrumentation. Sensors and</p>

Actuators. A: Physical 104 (2003) 86-93. IF(2003).

KUTIN. JoŽe, BAJŠIČ, Ivan. Characteristics of a dynamic pressure generator based on loudspeakers. Sensors and Actuators, A: Physical 168 (2011) 149-154. IF(2011) = 1.802 (1. detrtina)

KUTIN. JoŽe, BOBOVNIK, Gregor, BAJŠIČ, Ivan. Dynamic effects in a clearance-sealed piston prover for gas flow measurements. Metrologia 48 (2011) 123-132.

RUPNIK, Klemen, KUTIN. JoŽe, BAJŠIČ, 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, BAJŠIČ, Ivan. Heat exchange effects on the performance of a clearance-sealed piston prover for gas flow measurements. Metrologia 52 (2015) 857-863. IF(2015) : 2.5

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

### **doc.dr. Drago BRAČUN**

BRACUN, Drago, SLUGA, Alojzij. stereo vision based measuring system for online welding path inspection. Journal of materials processing technology, ISSN 0924-0136. 2015, vol. 223, str. 328-336. IF(2015)=2.752

BUDAK, Igor, VUKELIĆ, Djordje, BRAČUN, Drago, HODOLIC, Janko, Sokovla, Mirko. Pre-processing of point data from contact and optical 3D digitization sensors. Sensors, ISSN 1424-8220, 2012, vol. 72, no. 7, str. 1100-1126. IF(2012)=1.165

BRAČUN, Drago, GRUDEN, Valter, MOZINA, Janez. A method for surface quality assessment of die-castings based on laser triangulation. Measurement science & technology, ISSN 0957-0233, 2008, letn. 19, št. 4, str. 041701. IF(2008)=1.74

BRAČUN, Drago, JEZERSEK, Matija, DIČIČ, Janez. Triangulation model taking into account light sheet curvature. Measurement Science & Technology, ISSN 0957-0233, 2006, letn. 17, št. 8, str. 2191-2196. IF(2006)=4.386

BRACUN, Drago, DIČIČ, Janez, MOZINA, Janez. Optodynamic measurement of a non-stationary temperature field in air by multiple laser-beam deflection. Measurement