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| **UČNI NAČRT PREDMETA / COURSE SYLLABUS** | | | | | | | | | | | | | | | | | |
| **Predmet:** | | | Meritve | | | | | | | | | | | | | | |
| **Course title:** | | | Measurements | | | | | | | | | | | | | | |
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| **Študijski program in stopnja**  **Study programme and level** | | | | | **Študijska smer**  **Study field** | | | | | | | | **Letnik**  **Academic year** | | **Semester**  **Semester** | | |
| Univerzitetni študijski program prve stopnje Elektrotehnika | | | | | **Ni smeri** | | | | | | | | 2. | | zimski | | |
| 1st cycle academic study programme Electrical Engineering | | | | | **/** | | | | | | | | **2.** | | **winter** | | |
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| **Vrsta predmeta / Course type** | | | | | | | | | | | | Obvezni – strokovni/ compulsory professional | | | | | |
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| **Univerzitetna koda predmeta / University course code:** | | | | | | | | | | | | 64112 | | | | | |
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| **Predavanja**  **Lectures** | **Seminar**  **Seminar** | | | **Vaje**  **Tutorial** | | | **Klinične vaje**  **work** | | | | **Druge oblike študija** | | | **Samost. delo**  **Individ. work** | |  | **ECTS** |
| **45** |  | | | **45** | | |  | | | |  | | | **85** | |  | **7** |
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| **Nosilec predmeta / Lecturer:** | | | | | Janko Drnovšek, Dušan Agrež | | | | | | | | | | | | |
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| **Jeziki /**  **Languages:** | | **Predavanja / Lectures:** | | | | slovenski/Slovenian | | | | | | | | | | | |
| **Vaje / Tutorial:** | | | | slovenski/Slovene | | | | | | | | | | | |
| **Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:** | | | | | | | | |  | **Prerequisits:** | | | | | | | |
| Vpis v letnik študija | | | | | | | | |  | Enrolment in the year of the course | | | | | | | |
| **Vsebina:** | | | | | | | |  | | **Content (Syllabus outline):** | | | | | | | |
| a) meroslovni sistemi (veličine, enote, realizacija, etaloni, diseminacija, sledljivost, umerjanje, preskušanje)  b) temeljni principi merjenja in informacijska vsebina signalov, merilne strategije  c) merilna točnost in negotovost (absolutni in relativni pogrešek, merilni rezultat, prava vrednost, statistična obdelava rezultatov, merilna negotovost), prilagajanje signalov  d) merjenje električnih veličin (napetost, tok, moč, upornost, kapacitivnost, induktivnost, frekvenca, fazni kot, faktor moči, frekvenčni spekter...)  e) uporaba osnovne merilne instrumentacije (ampermeter, voltmeter, vatmeter, osciloskopi, vektorski analizator....)  f) merjenje neelektričnih veličin (temperatura, vlaga, tlak, sila, pomik, hrup, ...) | | | | | | | |  | | a) Metrology systems (quantities, units and realization, etalons, disemination, traceability, calibration, conformity assessment);  b) Fundamental principles of measurement and information content of signals, measurement strategies;  c) Measuring accuracy and uncertainty (absolute and relative errors, measurement result, true value, statistic analysis, measurement uncertainty), signal conditioning;  d) Measurement of electrical quantities (voltage, current, power, resistance, capacitance, inductance, frequency, phase, power factor, frequency spectrum, ...);  e) Application of basic measuring instrumentation (ammeter, voltmeter, wattmeter, oscilosscope, vector analyser);  f) Measurement of non-electrical quantities (temperature, humidity, preasure, force, lenght, noise, ...). | | | | | | | |

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| **Temeljni literatura in viri / Readings:** | | | | | |
| 1. Dunn P.F., Measurement and Data Analysis for Engineering and Science, Second Edition, CRC Press, 2010.  2. Morris A.S., Measurement and Instrumentation Principles, Third Edition, Oxford: Butterworth-Heinemann, 2010.  3. Agrež D. in ostali, Meritve - laboratorijski praktikum (ver. 3), University of Ljubljana, Faculty of Electrical Engineering, 2013.  4. G. Geršak in ostali, Metrologija, University of Ljubljana, Faculty of Electrical Engineering, 2012.  5. Tumanski S., Principles of Electrical Measurement, Taylor & Francis, CRC Press, 2006.  6. Evaluation of measurement data - Guide to the expression of uncertainty in measurement International Joint Committee for Guides in Metrology, 2008, (<http://www.bipm.org/en/publications/guides/gum.html>). | | | | | |
| **Cilji in kompetence:** | |  | | **Objectives and competences:** | |
| a) proučiti temelje metrologije in metroloških sistemov, enote SI, povezave z drugimi področji znanosti,  b) uvesti osnovne principe in obdelati prevladujočo tehniško prakso pri merjenju najbolj  pomembnih veličin v tehniki, lastnosti merilnih signalov  c) seznaniti s postopki in metodami merjenja osnovnih električnih veličin in ugotavljanje karakteristik merilnih pretvornikov  d) koncept merjenja ter razumevanje in interpratacija merilnih rezultatov  e) proučiti vlogo statistike in analizo merilne negotovosti  f) uvod v praktično laboratorijsko/instrumentacijsko delo  g) seznanitev z varnostnimi zahtevami in zaščito pri uporabi merilne instrumentacije in stikom z električno energijo | |  | | a) To studythe fundamentals of metrology and metrological systems, Si units, connections with other fields of science;  b) To introduce the basic principles of measurement of most important quantities in engineering, properties of measurement signals;  c) To learn the approaches and methods of measurement of basic electric quantities and caracteristics of measurement transducers;  d) To extend the concepts of measurement and comprehension and interpretation of the measurement results;  e) To study the meaning of statistic and analysis of measurement uncertainty;  f) Besides its theoretical aspects it helps the preparation for laboratory practices.  g) To learn the security requirements and protection when using measurement instrumentation in connection with power supply. | |
| **Predvideni študijski rezultati:** | | |  | **Intended learning outcomes:** | |
| a )osnovni pojmi iz področja meroslovja,  b)razumevanje merjenj kot osnovne znanstvene discipline za pridobivanje in ovrednotenje informacij,  c)metode merjenja temeljnih elektromagnetnih veličin in neelektričnih veličin,  d) merilna točnost in negotovost,  e)podajanje in interpretacija merilnih rezultatov | | |  | a) To get information and adopt the basics of metrology;  b) Understanding of measurements as basic discipline for acquisition and evaluation of information;  c) Understanding of methods how to measure basic elektromagnetic quantities;  d) To know how to express the mesasurement results with measurement uncertainty;  e) To know how to collect, interpret and evaluate measurement results. | |
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| **Metode poučevanja in učenja:** | | |  | **Learning and teaching methods:** | |
| predavanja, laboratorijske vaje | | |  | Lectures, laboratory tutorials. | |
| **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. | **30%,**  **50%**  **20%** | | | | 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. Agrež D., "Weighted multi-point interpolated DFT to improve amplitude estimation of multi-frequency signal", IEEE Transactions on Instrumentation and Measurement, 2002, vol. 51, no. 2., pp. 287-292. 2. Štremfelj J., Agrež D., "'Nonparametric estimation of power quantities in the frequency domain using Rife-Vincent windows", IEEE Transactions on Instrumentation and Measurement, 2013, vol. 62, no. 8, pp. 2171-2184. 3. Beguš S., Bojkovski J., Drnovšek J., Geršak G., "Magnetic effects on thermocouples", Measurement science & technology, 2014, vol. 3, no. 25, pp. 1-11. 4. Žužek V., Batagelj V., Drnovšek J., Bojkovski J., "Effect of bushings in thermometric fixed-point cells", Measurement, 2016, vol. 78, pp. 289-295. 5. D. Agrež, "A/D Conversion with Non-uniform Differential Quantization", Design, Modeling and Testing of Data Converters, P.Carbone et all (eds.), pub. by Springer-Verlag Berlin Heidelberg, 2014, pp. 277-306. | | | | | |