UČNI NAČRT PREDMETA / COURSE SYLLABUS	
Predmet:	INSTRUMENTALNE METODE
Course Title:	INSTRUMENTAL METHODS

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
UŠP Kemija, 1. stopnja	**/**	**3.**	**5.**
USP Chemistry, 1st Cycle	**/**	**3rd**	**5th**

Vrsta predmeta / Course Type: obvezni / Mandatory

Univerzitetna koda predmeta / University Course Code: KE133

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Work	Druge oblike študija	Samost. delo Individual Work	ECTS
60	**15**	**/**	**/**	**/**	**75**	**5**

Nosilec predmeta / Lecturer: prof. dr. Jurij Reščič / Dr. Jurij Reščič, Full Professor
prof. dr. Matija Tomšič / Dr. Matija Tomšič, Full Professor

Jeziki / Languages:

Predavanja / Lectures:	**slovenski / Slovenian**
Vaje / Tutorial:	**/**

Pogoji za vključitev v delo oz. za opravljanje študijskih obveznosti:	Prerequisites:
Študent oz. kandidat mora imeti predmet opredeljen kot študijsko obveznost.	The course has to be assigned to the student.

Vsebina:	Content (Syllabus outline):
Osnove meroslovja Merjenje. Mednarodni sistem enot. Standardi in hierarhija standardov, meroslovne ustanove. Napake pri merjenju. Umerjanje inštrumentov. Sledljivost merilnih priprav do nacionalnih in mednarodnih standardov	**Introduction to metrology** Measuring. Metric system of units. Standards and their hierarchy, metrological institutions. Measuring errors. Calibration of instruments. Traceability of measuring equipment to national and international standards.
Merilni sistem Elementi za zajem, preoblikovanje, ojačenje, prikaz in prenos signala. Blokovna shema instrumenta. Statične in dinamične karakteristike.	**Measuring system** Elements for acquisition, transformation, amplification, display and transfer of a signal. Block diagram of an instrument. Static and dynamic characteristics.
Merjenje osnovnih fizikalnih količin	**Measuring basic physical quantities:**

Mejenje tlaka, temperature, nivoja, pretoka, mase, gostote in relativne vlažnosti.

Optični elementi v spektroskopiji
Izvori in detektorji elektromagnetnega valovanja (RF, IR,VIS, UV) za uporabo v spektroskopiji. Monokromatorji. Stefanov in Beerov zakon.

Elektrika in osnovne električne meritve
Električno polje, tok in prevajanje. Enosmerni in izmenični tok, Kazalčni diagrami. Polprevodniki, energijski pasovi. Tipi uporov in uporovna vezja. Računska obravnava osnovnih elektronskih vezij. RC, RL, RLC vezje in frekvenčni filtri. Amplitudno razmerje.

Magnetno polje
Inštrument na vrtljivo tuljavico (galvanometer). Analogni in digitalni merilniki električnih količin (ampermeter, voltmeter, ohmmeter, Wheatstoneov most, osciloskop). Snov v magnetnem polju. Transformator.

Osnovni polprevodniški elektronski elementi in gradniki elektronskih merilnih instrumentov
Električne komponente in vezja. Dioda in Zenerjeva dioda. Tranzistor, osnovne vezave in aplikacije, tipi tranzistorjev. Usmernik in stabilizator napetosti. Operacijski ojačevalniki in njihova uporaba.

Zajemanje, pretvorba in procesiranje signalov
Digitalizacija. Digitalna elektronika in mikroračunalniki. Prožilniki, števci, A/D in D/A pretvorniki. Logična vezja. Povezava merilnih instrumentov z računalniki.

Signal in šum
Izvori šuma in metode za povečanje razmerja med signalom in šumom.

Instrumenti za merjenje

pressure, level, flow rate, mass, temperature and relative humidity.

Optical elements in spectroscopy
Sources, monochromators and detectors of EM radiation (RF, UV, VIS, IR) used in spectrometers. Stefan's and Beer's law.

Electricity and basic electrical measurements
Electric field, current and conduction. Direct and alternating current, Phasor diagram. Semiconductors, energy bands. Resistor types and resistor circuitry. Numerical consideration of basic electronic circuits. RC, RL, RLC circuit and frequency filters. Amplitude ratio.

Magnetic field
Moving coil meter (galvanometer). Analogue and digital electrical measuring equipment (ammeter, voltmeter, ohmmeter, Wheatstone bridge, oscilloscope). Matter in magnetic field. Transformer.

Basic electronic semiconductor elements and components of electronic measuring instruments
Electrical components and circuits.
Diode and Zener diode. Transistor and basic applications, transistor types. Rectifier and voltage regulator. Operational amplifiers and their basic application.

Data acquisition, conversion and processing
Digitalization. Digital electronics and microcomputers. Triggers, counters, A/D and D/A converters. Logic circuits. Linking measuring instruments with computers.

Signal and noise.
Sources of noise and methods for increasing the ratios between a signal and noise.

Measuring instruments for:
- emission, absorption, polarization, scattering

- emisije, absorpcije, polarizacije, sipanja in uklona svetlobe (UV-VIS spektrofotometer, polarimeter, refraktometer). - Potenciometrija, kulometrija, amperometrija, konduktometrija, pH meter, konduktometer, galvanostat, potenciostat, kulometer, elektrokemijski senzorji. - razmerja m/e (masni spektrometer). - termičnih karakteristik (TGA, DTA, mikrokalorimetrija, DSC in ITC).	and diffraction of light (UV-VIS spectrophotometer, polarimeter, refractometer). - Potentiometry, coulometry, amperometry, conductometry,pH meter, conductometer, galvanostat, potentiostat, coulometer, electrochemical sensors. - m/e ratios (mass spectrometer) - thermal characteristics (TGA, DTA, micro-calorimetry, DSC in ITC).
Osnove regulacije procesov Namen in pomen avtomatske regulacije procesov. Osnovni pojmi in terminologija. Povratna zanka. Odprti in zaprti regulacijski krog. Blokovni diagram, značilni elementi. Standardni signali za prenos informacije v regulacijski zanki. Izvršilni členi: Avtomatski regulirni ventil. Regulirne črpalke. Regulacijski načini Nezvezni (dvo in večpoložajna) in zvezni načini regulacije (proporcionalni, integralni, derivativni in kombinirani).	**Process control basics** Purpose and importance of automatic control processes. Basic concepts and terminology. Feedback loop. Open and closed control loop. Block diagram with typical elements. Standard signals for transmission of information in the control loop. Final control elements: pneumatic control valve and control pumps. Discontinuous (two and multiple position controllers) and continuous controllers: proportional, integral, derivative and combined.

Temeljna literatura in viri / Readings:

- D.A. Skoog, F.J.Holler, T.A. Nieman: Principles of Instrumental Analysis, 5th Ed., Harcourt Brace & Company, Philadelphia, 1998, Izbrana poglavja, 290 od 564 strani.
- A.J. Diefenderfer, B. E. Holton: Principles of Electronic Instrumentation, 3rd Ed., Saunders College Publishing, 1994.

Dodatna literatura:

- H.A. Strobel: Chemical Instrumentation, 3rd Ed., John Wiley & Sons, New York, 1989.
- Hobart H. Willard, Lynne L. Merritt,Jr., John A. Dean, Frank A. Settle, Jr.: Instrumental Methods of Analysis, 7th Ed., Wadsworth Publishing Company, Belmont, 1988.

Cilji in kompetence:	**Objectives and Competences:**

Cilj predmeta je posredovati slušateljem znanja potrebna za razumevanje delovanja in pravilno rokovanje z modernimi aparaturami v kemijskem laboratoriju. **Kompetence**: Razumevanje vloge in lastnosti funkcionalnih sklopov instrumentov, ki sodelujejo pri nastanku informacije o merjeni količini, njenem preoblikovanju in posredovanju uporabniku. Podrobneje so obdelani elektrokemijski in optični instrumenti.	*Objectives:* Providing the knowledge necessary for understanding the function and correct handling with modern equipment in a chemical laboratory. *Competences:* Understanding the function and properties of functional units of instruments for measuring quantities, with special emphasis on electrochemical and optical instruments.

Predvideni študijski rezultati:	**Intended Learning Outcomes:**
Znanje in razumevanje Absolvent tega predmeta pozna zgradbo in funkcijo osnovnih merilnih instrumentov in aparatur v kemijskem laboratoriju. Seznanjen je z izvorom in učinkom motečih vplivov na njihovo delovanje in na merski rezultat. Sposoben je odkrivanja in preprečevanja napak pri merjenju.	Knowledge and Comprehension A student becomes familiar with structure and function of basic instruments and apparatus found in a chemical laboratory. She/he is aware of limits of the instruments and is able to detect and avoid possible errors during measurements.
Uporaba Na pridobljenem znanju temelji pravilna izbira, uporaba in vzdrževanje aparatur v analitskem in raziskovalnem laboratoriju.	Application Acquired knowledge is a cornerstone of correct choice, usage, and maintenance of instruments in a chemical laboratory.
Refleksija Pridobljeno znanje bo lahko uporabil pri ostalih instrumentalnih metodah, ki niso bile posebej obravnavane in pri nadaljnjem študiju.	Analysis Acquired knowledge can be applied to other instrumental techniques not covered during this course.
Prenosljive spretnosti Pridobil in utrdil bo spretnosti pridobljene tudi pri sorodnih predmetih kot so spremljanje in razumevanje strokovne literature, sposobnost kritične ocene rezultatov, strokovnega poročanja in vestnega in natančnega dela.	Skill-transference Ability A student will consolidate the skills learned in the related subjects such as monitoring and understanding of the scientific literature, critical evaluation of results, reporting a professional and conscientious and thorough work.

Metode poučevanja in učenja:	**Learning and Teaching Methods:**
Predavanja, seminar	- Lectures and seminar.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	**Assessment:**
Pisni izpit.		Written exam.

Reference nosilca / Lecturer's references:

- BONČINA, Matjaž, LAH, Jurij, REŠČIČ, Jurij, VLACHY, Vojko. Thermodynamics of the lysozyme-salt interaction from calorimetric titrations. *J. Phys. Chem., B Condens. mater. surf. interfaces biophys.*, **2010**, vol. 114, no. 12, str. 4313-4319.

- BONČINA, Matjaž, REŠČIČ, Jurij, VLACHY, Vojko. Solubility of lysozyme in polyethylene glycol-electrolyte mixtures : the depletion interactions and ion-specific effects. *Biophys. J.*, **2008**, vol. 95, no. 3, str. 1285-1294.

- ZALAR, Petra, TOMŠIČ, Matija, JAMNIK, Andrej, REŠČIČ, Jurij. Osmometry and small-angle x-ray scattering of human serum albumin in buffer solutions. *Acta chim. slov.*, **2006**, vol. 53, št. 3, str. 344-349.

- TOMŠIČ, Matija, CERAR, Jure, JAMNIK, Andrej. Characterization of the supramolecular assembly in 1,4-butanediol. Journal of molecular liquids, 2018, vol. 259, str. 291-303.

- DOGŠA, Iztok, CERAR, Jure, JAMNIK, Andrej, TOMŠIČ, Matija. Supramolecular structure of methyl cellulose and lambda- and kappa-carrageenan in water : SAXS study using the string-of-beads model. Carbohydrate polymers, 2017, vol. 172, str. 184-196.

- TOMŠIČ, Matija, PROSSNIGG, Florian, GLATTER, Otto. A thermoreversible double gel : characterization of a methylcellulose and κ-carrageenan mixed system in water by SAXS, DSC and rheology. Journal of colloid and interface science, 2008, vol. 322, no. 1, str. 41-50.