

## UČNI NAČRT PREDMETA / COURSE SYLLABUS

<b>Predmet:</b>	Elektrokemijski senzorji
<b>Course title:</b>	Electrochemical Sensors

Študijski program in stopnja Study programme and level	Študijska smer Study field	Letnik Academic year	Semester Semester
Senzorske tehnologije, 3. stopnja	/	1	1
Sensor technologies, 3 <sup>rd</sup> cycle	/	1	1

**Vrsta predmeta / Course type** Izbirni / Elective

**Univerzitetna koda predmeta / University course code:** ST3-530

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje work	Druge oblike študija	Samost. delo Individ. work	ECTS
15	15			15	105	5

*\*Navedena porazdelitev ur velja, če je vpisanih vsaj 15 študentov. Drugače se obseg izvedbe kontaktnih ur sorazmerno zmanjša in prenese v samostojno delo. / This distribution of hours is valid if at least 15 students are enrolled. Otherwise the contact hours are linearly reduced and transferred to individual work.*

**Nosilec predmeta / Lecturer:** Doc. dr. Kristina Žužek Rožman

<b>Jeziki /</b>	<b>Predavanja / Lectures:</b>	Slovenski ali angleški / Slovene or English
<b>Languages:</b>	<b>Vaje / Tutorial:</b>	Slovenski ali angleški / Slovene or English

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

Zaključen študij druge stopnje ustrezne (naravoslovne ali tehniške) smeri ali zaključen študij drugih smeri z dokazanim poznavanjem osnov področja predmeta (pisna dokazila, pogovor).

**Prerequisites:**

Completed second cycle studies in natural sciences or engineering or completed second cycle studies in other fields with proven knowledge of fundamentals in the field of this course (certificates, interview).

**Vsebina:**

- Potenciometrični senzorji, vključujoč potenciometrične titracije, delovanje ionoselektivnih elektrod, plinskih elektrod ter senzorjev pH-ja, plinov in encimov.
- Amperometrični in voltometrični senzorji, vključujoč amperometrične titracije, membranske elektrode, modificirane elektrode ter tehnike za povečanje njihove občutljivosti in selektivnosti za elektro-zaznavanje.
- Bioelektrokemija v bioelektroenergetiki, bioelektroanalizi in katalizi ter bodoča uporaba v biosenzorskih tehnologijah.
- Umeščanje poznanih elektrokemijskih tehnologij in njihova nadgradnja do končne uporabe v sodelovanju z Institutom Ruđer

**Content (Syllabus outline):**

- Potentiometric sensors, including potentiometric titrations, functioning of ion-selective electrodes, glass electrodes and pH sensors, gas sensors and enzyme-selective electrodes.
- Amperometric and voltametric sensors including amperometric titrations, membrane electrodes, modified electrodes and selectivity and sensitivity-increment techniques, and electro analysis/detection.
- Bioelectrochemistry for bioenergetics, bioelectroanalysis and bioelectrocatalysis. Future prospects in biosensing.
- Placement of current electrochemical technologies and its upgrade to final application in collaboration with Institute Ruđer Bošković

Bošković iz Zagreba, Hrvatska, in Seoul National University (School of Mechanical & Aerospace Engineering) in Korea Advanced Institute of Science and Technology (KAIST) at the Center for Integrated Smart Sensors (CISS), Seoul, Južna Koreja.

from Zagreb, Croatia and Seoul National University (School of Mechanical & Aerospace Engineering) and Korea Advanced Institute of Science and Technology (KAIST) at the Center for Integrated Smart Sensors (CISS), Seoul, South Korea.

### Temeljni literatura in viri / Readings:

#### Knjige / Books

- J. Bard, Z. R. Faulkner, *Electrochemical Methods, Fundamentals and Applications*, John Wiley & Sons, Inc, New York, 2001.
- S. Alegret, A. Merkoci, *Electrochemical Sensor Analysis*, Elsevier, Amsterdam, 2007.

#### Izbrani članki v revijah / Selected papers from periodicals:

- Biosensors and bioelectronics
- Electrochimica Acta
- Sensors and actuators B-chemical

#### Literatura proizvajalcev instrumentov / Documents by instrument manufacturers

### Cilji in kompetence:

#### Cilji:

- poznavanje in razumevanje elektrokemijskih principov in metod za analize namene kot tudi poznavanje skrajnostnih meja slednjih ter njihova nadgradnja,
- prepoznavanje specifičnosti analitskega problema ter poglobljeno znanje v smeri predlaganja najbolj ustrezne analize/zaznavne tehnike,
- sposobnost analize signalov iz detektorja ter njihova interpretacija,
- predvidevanje ter podajanje nadaljnjih ukrepov za izboljšavo učinkovitosti metode.

#### Kompetence:

- izbira ustrezne analize metode oz. tehnike za specifičen problem analize oz. zaznavanja,
- sposobnost postavitve celotnega sistema zaznavanja,
- sposobnost izvedbe meritve na zahtevanem analiznem sistemu,
- sposobnost kritične evalvacije pridobljenih eksperimentalnih podatkov.

### Objectives and competences:

#### Objectives:

- knowledge and understanding of electrochemical measurements and methods for analytical purposes as well as cutting-edge approaches to related analytical issues,
- recognition of the specificity of an analyte and proposing an appropriate method,
- analysis of the detector signals and their evaluation and interpretation,
- prediction and guidelines for improved performance.

#### Competences:

- ability to select an appropriate analysis method for a specific analytical problem,
- ability to construct a working electrochemical electro system,
- ability to perform a measurement/data run on the assembled system,
- ability to critically evaluate the obtained experimental data.

### Predvideni študijski rezultati:

#### Znanje in razumevanje:

- poznavanje elektrokemijskih principov merjenja ter postavitve celotnega elektrokemijskega

### Intended learning outcomes:

#### Knowledge and understanding:

- understanding of electrochemical measurements principles and set-ups,

merilnega sistema, • razumevanje elektrokemijskega izvora izmerjenih signalov, • sposobnost nadgradnje pridobljenega znanja v uporabne namene.	• understanding of the measured signals of electrochemical origin, • upgrade and application of obtained knowledge.
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**Metode poučevanja in učenja:**

Interaktivna predavanja.  
 Prepoznavanje ter reševanje analitskih problemov.  
 Interaktivno reševanje realnega problema, povezanega z doktorskim študijem študenta.

**Learning and teaching methods:**

Interactive lectures.  
 Identification and solving of analytical/sensing problems.  
 Interactive solving of a problem related to the PhD topic.

Načini ocenjevanja:	Delež (v %) / Weight (in %)	Assessment:
Seminar z zagovorom reševanja realnega problema.	50 %	Seminar with the presentation of a case-study.
Ustni izpit.	50 %	Oral exam.

**Reference nosilca / Lecturer's references:**

- ŽUŽEK ROŽMAN, Kristina, PEČKO, Darja, TRAFELA, Špela, SAMARDŽIJA, Zoran, SPREITZER, Matjaž, JAGLIČIČ, Zvonko, NADRAH, Peter, ZORKO, Mateja, BELE, Marjan, TIŠLER, Tatjana, PINTAR, Albin, ŠTURM, Sašo, KOSTEVŠEK, Nina. Austenite-martensite transformation in electrodeposited Fe<sub>70</sub>Pd<sub>30</sub>Fe<sub>70</sub>Pd<sub>30</sub> NWs : a step towards making bio-nano-actuators tested on in-vivo systems. *Smart materials and structures*, ISSN 0964-1726, February 2018, vol. 27, str. 035018 2018, 19 str1-10, doi: [10.1088/1361-665X/aaacb0](https://doi.org/10.1088/1361-665X/aaacb0). [COBISS.SI-ID [31185447](https://www.cobiss.si/id/31185447)]
- ARSHAD, Muhammad Shahid, PROENCA, Mariana P., TRAFELA, Špela, NEU, Volker, WOLFF, Ulrike, STIENEN, Sven, VAZQUES, Manuel, KOBE, Spomenka, ŽUŽEK ROŽMAN, Kristina. The role of the crystal orientation (c-axis) on switching field distribution and the magnetic domain configuration in electrodeposited hcp Co-Pt nanowires. *Journal of physics. D, Applied physics*, ISSN 0022-3727, May 2016, vol. 49, no. 18, str. 1-13, ilustr. <http://iopscience.iop.org/article/10.1088/0022-3727/49/18/185006/pdf>, doi: [10.1088/0022-3727/49/18/185006](https://doi.org/10.1088/0022-3727/49/18/185006). [COBISS.SI-ID [5897754](https://www.cobiss.si/id/5897754)]
- PEČKO, Darja, ŠTURM, Sašo, KOBE, Spomenka, ŽUŽEK ROŽMAN, Kristina. Potentiostatically electrodeposited hard-magnetic Fe-Pd-based nanowires. *IEEE transactions on magnetics*, ISSN 0018-9464, 2015, vol. 51, no. 7, str. 9600204 -1-9600204-4, doi: [10.1109/TMAG.2015.2392083](https://doi.org/10.1109/TMAG.2015.2392083). [COBISS.SI-ID [28783911](https://www.cobiss.si/id/28783911)]
- PEČKO, Darja, KOSTEVŠEK, Nina, PIHLAR, Boris, SAMARDŽIJA, Zoran, KOBE, Spomenka, ŽUŽEK ROŽMAN, Kristina. Electrochemical studies of Fe and Pd deposition and their influence on the co-deposition of the Fe-Pd alloy. *Journal of electroanalytical chemistry*, ISSN 1572-6657, 2015, vol. 738, str. 51-60, doi: [10.1016/j.jelechem.2014.11.027](https://doi.org/10.1016/j.jelechem.2014.11.027). [COBISS.SI-ID [28199975](https://www.cobiss.si/id/28199975)]
- KOSTEVŠEK, Nina, ŽUŽEK ROŽMAN, Kristina, PEČKO, Darja, PIHLAR, Boris, KOBE, Spomenka. A comparative study of the electrochemical deposition kinetics of iron-palladium alloys on a flat electrode and in a porous alumina template. *Electrochimica Acta*, ISSN 0013-4686. [Print ed.], 2014, vol. 125, str. 320-329, doi: [10.1016/j.electacta.2014.01.115](https://doi.org/10.1016/j.electacta.2014.01.115). [COBISS.SI-ID [27452967](https://www.cobiss.si/id/27452967)]