

## UČNI NAČRT PREDMETA / COURSE SYLLABUS

<b>Predmet:</b>	Sistemi, naprave in materiali za izkoriščanje nekonvencionalnih energetskih virov
<b>Course title:</b>	Systems, Facilities and Materials for Alternative Energy Sources

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

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

**Univerzitetna koda predmeta / University course code:** EKO3-775

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:** Prof. dr. Boris Orel

**Jeziki / Predavanja / Lectures:** slovenščina, angleščina  
Slovenian, English

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

Znanje, ki je ekvivalentno izobrazbi druge stopnje ali univerzitetni izobrazbi s področja naravoslovja ali tehnologije.

**Prerequisites:**

Knowledge, which is equivalent to a second level or university degree from natural sciences or technology.

### Vsebina predmeta

Sončni absorberji in sončni zbiralniki: materiali, tehnologije.

Fotoelektrokemijski sistemi: delovanje Graetzlovih fotonapetostnih celic; priprava oksidov kovin prehoda; ionski redoks elektroliti z nanokompozitno strukturo; izdelava celic in meritve njihovih lastnosti.

Pasivni sistemi za izrabo sončnega sevanja ("smart" windows): optično preklopni sistemi (elektrokromni, fotokromni in gasokromni sistemi).

Materiali s fotokatalitskimi lastnostmi: nanoporozni titanov(IV) oksid, superhidrofilnost.

Materiali in načrtovanje

- osnovne značilnosti materialov,
- energija: toplotno okolje,

### Course Content

Solar absorbers and solar collectors: materials, technologies.

Photoelectrochemical systems: basic principles of the operation of photoelectrochemical Gretzel type photovoltaic cell; the preparation of components – nanocrystalline transition metal oxides acting as photoanodes, ionic-redox electrolytes with nanocomposite structure acting as a "hole" transporting media, assembling of the cells, efficiency measurements and the evaluation of their stability.

Basic principles of the operation of the passive optical switching systems for light control in buildings: "smart" electrochromic windows, gasochromic systems and thermochromic and photochromic devices.

The preparation and functioning of materials

- vrste in karakteristike pametnih materialov: pametni proizvodi, pametne komponente in sistemi.

exhibiting photocatalytic properties: nanoporous titan (IV) oxide with photocatalytic and superhydrophilic properties.

#### Materials and design

- Basic characteristics of materials;
- Energy: thermal environment;
- The types and characteristics of smart materials: smart products, smart components and systems.

### Temeljna literatura in viri / Basic literature and sources

- U. Schubert, N.Huesing. Synthesis of Inorganic Materials. New York: Wiley-VCH (2000), 396 p., ISBN 3-527-29550X
- G.Gaiglitz, T-Vo-Dinh (eds.). Handbook of Spectroscopy, Vol.1 and 2. Weinheim: Wiley-VCH (2003), ISBN 3-52729782-0
- C.G.Granqvist. Handbook of Inorganic Electrochromic Materials. Amsterdam: Elsevier (1995), 633 p., ISBN 0-44489930-8
- G.Hodes (ed.). Electrochemistry of Nanomaterials. Weinheim: Wiley-VCH (2001), 310 p., ISBN 3-527-29836-3
- Z.W.Wicks, F.N.Jones, S.P.Pappas: Organic Coatings , Science and Technology. New York: Wiley-Interscience (1999), 630 p., ISBN 0-471-24507-0
- C. G. Granqvist (Ed), Pergamon Press, ISBN 0-08-040937-7, Materials science for solar energy conversion systems
- Orel, Boris, Šurca Vuk Angela, Slemenik Perše Lidija : Sončni sprejemniki za pridobivanje sončne toplote : učno gradivo = Solar collectors for generation of solar heat : course notes, Ljubljana: Kemijski inštitut, 2008. 147 str., ilustr. ISBN 978-961-6104-12-8

### Cilji predmeta

Cilj predmeta je seznaniti študente s principi inženirskega načrtovanja, oblikovanja in systemskega pristopa k reševanju problemov pri načrtovanju pametnih materialov in tehnologij.

Študent pridobi kompetence potrebne za delo na področju sistemov, naprav in materialov za izkoriščanje nekonvencionalnih energetskega virov.

### Course Aims

The aim of this course is to acquaint students with the principles of engineering planning, design and systematic approach to planning of smart materials and systems.

Students will gain competences necessary to work in the research field of systems, facilities and materials for alternative energy sources.

### Predvideni študijski rezultati

#### Znanje in razumevanje:

- Razumevanje predmetnega področja.

#### Vrednotenje in sinteza:

- obvladanje izbranih raziskovalnih metod, postopkov in procesov,
- razvoj kritične in samokritične presoje,
- sposobnost komunikacije raziskovalnih rezultatov v mednarodnem okolju,
- sposobnost dela v skupini,
- obvladovanje izdelave naprav za fototermično in fotoelektrično konverzijo sončnega sevanja.

### Expected learning outcomes

#### Knowledge and understanding

- The student will understand this field of research.

#### Evaluation and synthesis:

- mastering selected research methods, procedures and processes,
- development of critical thinking and self-assessment,
- development of communication skills to present research results in an international environment,
- ability to cooperate in a team,
- mastering the production of photovoltaic and photoelectric devices for solar energy conversion.

**Metode poučevanja in učenja**

- Predavanja z aktivno udeležbo študentov (razlaga, diskusija, vprašanja, primeri, reševanje problemov).
- Seminarska naloga.
- Individualne in/ali skupinske konzultacije (diskusija, dodatna razlaga, obravnava specifičnih vprašanj).

**Learning and teaching methods**

- Lectures with active participation of students (presentation, discussion, questions, examples, solving of the problems).
- Seminar work.
- Individual and / or group consultation (discussion, additional explanation, specific questions).

Načini preverjanja znanja	Delež / Weight	Assessment
Seminar in ustni izpit, v katerem kandidat dokaže poznavanje in razumevanje temeljnih vsebin predmeta in predstavi njihovo vključevanje v svoj raziskovalni projekt pred komisijo, ki jo sestavljata nosilec predmeta ter mentor podiplomca. K predstavitvi so vabljeni vsi sodelavci pri predmetu in v projektu.		Seminar and oral exam, in which the candidate demonstrates his/her knowledge and understanding of the essential course content, and presents how this new knowledge can be included in his/her research project – in front of the course leader and postgraduate's project supervisor.
• ocenjuje se pisni del izpita;	30 %	• written part of the exam;
• ocenjuje se ustni del izpita;	30 %	• oral part of the exam;
• ocena seminarske naloge.	40 %	• seminar work.

**Izbrane reference nosilca / Selected references of the course leader**

MIHELČIČ, Mohor, FRANCETIČ, Vojmir, KOVAČ, Janez, SURCA, Angelja Kjara, OREL, Boris, KUNIČ, Roman, PEROS, Dimitrios., Novel sol-gel based selective coatings : from coil absorber coating to high power coating. Solar energy materials and solar cells, 2015, vol. 140, 232-248. [COBISS.SI-ID 7094113].

HAJZERI, Metka, SLEMENIK PERŠE, Lidija, KOŽELJ, Matjaž, OREL, Boris, ŠURCA VUK, Angela. Structural investigation of ormolytes for EC devices : IR spectroscopic characterization and relation between viscoelastic properties, conductivity and optical modulation. Solar energy materials and solar cells, ISSN 0927-0248. [Print ed.], Aug. 2015, vol. 139, str. 51-64. [http://ac.els-cdn.com/S0927024815001105/1-s2.0-S0927024815001105-main.pdf?\\_tid=ff4913d0-e291-11e4-b775-00000aab0f02&acdnat=1429007920\\_1015989770459ec6202c344a3c71ca78](http://ac.els-cdn.com/S0927024815001105/1-s2.0-S0927024815001105-main.pdf?_tid=ff4913d0-e291-11e4-b775-00000aab0f02&acdnat=1429007920_1015989770459ec6202c344a3c71ca78), doi: 10.1016/j.solmat.2015.03.005. [COBISS.SI-ID 5675802]].

MIHELČIČ, Mohor, SURCA, Angelja Kjara, JERMAN, Ivan, OREL, Boris, ŠVEGL, Franc, MOULKI, Hakim, FAURE, Cyril, CAMPET, Guy, ROUGIER, Aline, Comparison of electrochromic properties of Ni [sub] 1-xO in lithium and lithium-free aprotic electrolytes: from Ni [sub] 1-xO pigment coatings to flexible electrochromic devices. Solar energy materials and solar cells, 2014, vol. 120, 116-130. [COBISS.SI-ID 5335578]

SLEMENIK PERŠE, Lidija, MIHELČIČ, Mohor, OREL, Boris. Rheological and optical properties of solar absorbing paints with POSS-treated pigments. Materials chemistry and physics, ISSN 0254-0584. [Print ed.], Jan. 2015, vol. 149/150, str. 368-377. [COBISS.SI-ID 5607706]

SURCA, Angelja Kjara, KOŽELJ, Matjaž, OREL, Boris. Comparison of electrochromic devices with V- and Sn/Mo-oxide counter electrodes and (3-glycidoxypropyl)trimethoxysilane-based ormolytes with three different lithium salts. Solar energy materials and solar cells, ISSN 0927-0248. [Print ed.], Sep. 2014, vol. 128, str. 166-177. [COBISS.SI-ID 5508122]