

## UČNI NAČRT PREDMETA/COURSE SYLLABUS

**Predmet:** FOTOKEMIJA IN RADIKALI  
**Course Title:** PHOTOCHEMISTRY AND RADICALS

Študijski program in stopnja Study Programme and Level	Študijska smer Study Field	Letnik Academic Year	Semester Semester
MAG Kemija, 2. stopnja	/	1.	2.
USP Chemistry, 2 <sup>nd</sup> Cycle	/	1 <sup>st</sup>	2 <sup>nd</sup>

**Vrsta predmeta / Course Type:**

obvezni / Mandatory

**Univerzitetna koda predmeta / University Course Code:**

Predavanja Lectures	Seminar Seminar	Vaje Tutorial	Klinične vaje Work	Druge oblike študija	Samost. delo Individual Work	ECTS
45	15	LV 15	/	/	75	5

**Nosilec predmeta / Lecturer:**

Izr. prof. dr. Jernej Iskra / Dr. Jernej Iskra, Associate Professor

**Jeziki / Languages:**

**Predavanja / Lectures:** slovenski / Slovenian

**Vaje / Tutorial:** slovenski / Slovenian

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

Študent oz. kandidat mora imeti predmet opredeljen kot študijsko obveznost.

**Prerequisites:**

The course has to be assigned to the student.

**Vsebina:**

### Organska fotokemija.

a) Uvod. Interakcija spojin z elektromagnetnim valovanjem, delovanje mikrovalov in ultrazvoka. Absorpcija svetlobe, elektronska stanja in prehodi, lastnosti vzbujenih stanj, Jablonskijev diagram, kvantni izkoristek, prenos energije, dušenje.  
 b) Fotokemične reakcije. Izomerizacije, fragmentacije, adicije, substitucije, eliminacije, premestitve, , periciklične reakcije.  
 c) Foto elektron transfer, fotokataliza, kemiluminiscenca, singletni kisik, fotokemija v okolju.

### Kemija radikalov.

**Content (Syllabus outline):**

### Organic photochemistry

a) Introduction: Interaction of compounds and electromagnetic radiation mode of action of microwaves and ultrasound. Absorption of light, electronic states and transitions, properties of excited states, Jablonski diagram, quantum yield, energy transfer, quenching.  
 b) Photochemical reactions: isomerizations, fragmentation, additions, substitutions, eliminations, rearrangements, pericyclic reactions  
 c) Photo electron transfer, photocatalysis, kemiluminescence, singlet oxygen, environmental photochemistry.

### Chemistry of radicals

a) Uvod. Lastnosti radikalov. Reaktivnost in stabilnost radikalov, delokalizacija in elektronski efekti. Metode za tvorbo radikalov.  
b) Metode za detekcijo in opazovanje radikalov in vzbujenih stanj (ESR, laserska bliskovna fotoliza)  
c) Reakcije radikalov, značilnosti radikalskih reakcij, verižne reakcije, inhibicija.  
d) Pomembne radikalske reakcije v organski sintezi.

#### **Polimeri**

a) Uvod. Naravni polimeri, vrste polimerov, fizikalne lastni polimerov.  
b) Polimerizacija, vrste polimerizacije, reakcije na polimerih (zamreženje, graft polimerizacija), pretvorbe funkcionalnih skupin.  
c) Recikliranje, novi polimerni materiali.

a) Introduction: Properties of radicals, reactivity and stability, delocalization and electronic effects, formation of radicals.  
b) Methods for detection and observation of radicals (ESR, Laser flash photolysis).  
c) Radical reactions: characteristics of radical processes, chain reactions, inhibition.  
d) Radical reactions in organic synthesis.

#### **Polymers**

a) Introduction. Natural polymers, types of polymers, physical properties of polymers.  
b) Polymerization, types of polymerization, reactions on polymers (crosslinking, graft polymerization), transformation of functional groups.  
c) Recycling, novel polymeric materials.

#### **Temeljna literatura in viri / Readings:**

- *Modern Physical Organic Chemistry*, Eric V. Anslyn e tal., University Science Books, 2006 (izbrana poglavja).

Dodatna literatura:

- *Principles and Applications of Photochemistry*, Brian Wardle, Wiley, 2009.

- *Advanced Free Radical Reactions for Organic Synthesis*, Hideo Togo, Elsevier, 2004.

- *Principles of Polymer Chemistry*, Third Edition, A. Ravve, Springer, 2012.

#### **Cilji in kompetence:**

##### Cilji predmeta

Študent nadgradi znanja iz področij fotokemije in kemije radikalov in polimerov. Predmet seznanja študente s spremembami organskih molekul pod vplivom svetlobe v plinasti fazi, raztopinah, v prisotnosti vzbujevalcev in v heterogenih sistemih ter s procesi v okolju. Študent spozna osnovne značilnosti in uporabo radikalnih reakcij in se nauči izvajati omenjene pretvorbe v laboratoriju. Spozna osnovne reakcije priprave in modifikacij polimerov ter osnove o lastnostih polimerov.

#### **Objectives and Competences:**

##### Learning outcomes

Student acquires a new knowledge about the photochemical and photophysical phenomena and reactions. A student gets insight into the transformations of organic molecules under the influence of light and in the presence of sensitizers. Basic understanding of radicals and their reactions is supplemented by more detailed expertise about the properties of radicals, their behavior, typical radical reactions and synthetic use. Synthesis and properties of polymers, modification of polymer structure and functionality.

#### **Predvideni študijski rezultati:**

##### Znanje in razumevanje

Poznavanje narave in uporabe fotokemičnih procesov ter pomen fotokemičnih reakcij v okolju.

#### **Intended Learning Outcomes:**

##### Knowledge and Comprehension

Characteristics of photochemical processes, their uses and importance of photochemical reactions in the environment.

<p>Lastnosti radikalov. Značilnosti radikalskih procesov, uporaba radikalskih reakcij v sintezi. Neželjeni procesi in preprečevanje. Osnovne lastnosti in reakcije pridobivanja polimerov, modifikacije in uporaba polimerov v kemiji.</p>	<p>Properties of radicals. Characteristics of radical reactions, use in synthesis. Undesired radical processes and their inhibition. Basics of syntheses of polymers, modification and uses of polymers in chemistry.</p>
<p><u>Uporaba</u> Študent bo znal izbrati, zasnovati in uporabiti fotokemične in radikalske reakcije za sintezo organskih spojin in polimerov. Poznavanje neželenih radikalskih reakcij in njihovo preprečevanje. Poznavanje načinov priprave različnih polimernih materialov in njihovih lastnosti ter transformacij.</p>	<p><u>Application</u> Ability to choose, to design and to apply photochemical or radical reactions for the synthesis of organic materials or polymers. Knowledge about photochemical or oxidative deterioration reactions of organic materials and their inhibition. Preparation and modification of polymeric materials to attain desired properties or functionality.</p>
<p><u>Refleksija</u> Študent bo znal ugotoviti, kdaj poteka kemijski proces po fotokemični poti in kdaj je neka reakcija radikalska oziroma ionska. Z uporabo znanj, dobljenih pri tem predmetu bo znal voditi proces v želeno smer.</p>	<p><u>Analysis</u> Student will be able to distinguish photochemical and thermal processes, as well as radical and ionic ones.</p>
<p><u>Prenosljive spretnosti</u> -Dostopanje do literaturnih virov -Zbiranje, interpretacija in kritično vrednotenje podatkov -Identifikacija in reševanje problemov</p>	<p><u>Skill-transference Ability</u> Access to literature sources. Collection, interpretation and critical assessment of scientific information. Problem identification and solving.</p>

#### Metode poučevanja in učenja:

Predavanja, seminarji, laboratorijske vaje

#### Learning and Teaching Methods:

Lectures, seminar, laboratory work

#### Načini ocenjevanja:

Pisni izpit  
Ustni izpit  
Pogoj za pristop k izpitu je uspešno opravljeno praktično delo

Delež (v %) /

Weight (in %) /

#### Assessment:

Written exam  
Oral exam  
Accomplished practical work is a prerequisite to exam attendance.

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

- KAWADA, Kosuke, OKANO, Koji, **ISKRA, Jernej**, KRAJNC, Peter, CAHARD, Dominique. Selectfluor<sup>[sup]</sup>(TM) on a PolyHIPE material as regenerative and reusable polymer-supported electrophilic fluorinating agent. *Advanced Synthesis & Catalysis*, ISSN 1615-4150. [Print ed.], 2017, vol. 359, no. 4, str. 584-589, doi: [10.1002/adsc.201601312](https://doi.org/10.1002/adsc.201601312). [COBISS.SI-ID [30090791](https://www.cobiss.si/id/30090791)]

- MOŽINA, Štefan, STAVBER, Stojan, **ISKRA, Jernej**. Dual catalysis for the aerobic oxidation of benzyl alcohols - nitric acid and fluorinated alcohol. *European journal of organic chemistry*, ISSN 1434-193X, 2017, vol. 2017, no. 3, str. 448-452, doi: [10.1002/ejoc.201601339](https://doi.org/10.1002/ejoc.201601339). [COBISS.SI-ID [30184487](https://www.cobiss.si/id/30184487)]
- BEDRAČ, Leon, **ISKRA, Jernej**. Iodine(I) reagents in hydrochloric acid-catalyzed oxidative iodination of aromatic compounds by hydrogen peroxide and iodine. *Advanced Synthesis & Catalysis*, ISSN 1615-4150. [Print ed.], 2013, vol. 355, no. 7, str. 1243-1248, doi: [10.1002/adsc.201300127](https://doi.org/10.1002/adsc.201300127). [COBISS.SI-ID [26709799](https://www.cobiss.si/id/26709799)]

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