

## UČNI NAČRT PREDMETA / COURSE SYLLABUS

<b>Predmet:</b>	Organska analiza
<b>Course title:</b>	Organic Analysis

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:** EKO3-764

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. Ester Heath  
Doc. dr. Tina Kosjek

**Jeziki / Languages:** **Predavanja / Lectures:** slovenščina, angleščina  
Slovenian, English  
**Vaje / Tutorial:**

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

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

**Prerequisites:**

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

**Vsebina:**

Predmet je usmerjen v poznavanje separacijskih in kvalitativnih in kvantitativnih metod določitve organskih spojin v različnih vzorcih.

**Separacijske metode**, kjer se bodo študentje seznanili z:

- različnimi vrstami ekstrakcij, kot primer priprave vzorca: ekstrakcija tekoče-tekoče, ekstrakcija na trdnem nosilcu in mikro-ekstrakcija na trdnem nosilcu, ekstrakcija po Soxhletu, ekstrakcija z mikrovalovi, superkritična tekočinska ekstrakcija,

**Content (Syllabus outline):**

The course is focused on the role of separation and qualitative and quantitative determination techniques involved in organic analysis in different matrices.

**Separation techniques** will include:

- Different extraction techniques as an example of sample preparation including liquid-liquid extraction, solid phase extraction and solid phase micro-extraction, Soxhlet extraction, microwave assisted extraction, supercritical fluid extraction);
- Chromatographic separation with an emphasis

- kromatografsko ločbo s poudarkom na plinski in tekočinski kromatografiji,
- načeli zelene kemije v povezavi z izbiro ekstrakcijskih tehnik.

**Identifikacijske metode** bodo vključevale:

- poudarek bo na masni spektrometriji in sklopitvenih tehnikah kromatografskih in spektroskopskih metod,
- komplementarne tehnike bodo vključevale osnove sledečih spektroskopskih metod UV-VIS, IR, RAMAN in NMR,
- uporaba različnih masnih analizatorjev v masni spektrometriji in interpretacija masnih spektrov (»hands on«).

**Praktični primer (»Case study«):**

Vsak kandidat bo z nosilcem predmeta v povezavi s svojo doktorsko tematiko izbral praktični primer, kjer bo na osnovi znanja, pridobljenega v teoretičnem delu tega predmeta, ocenil možnosti in predlagal najbolj primerne separacijske in identifikacijske metode.

- on gas and liquid chromatography;
- Green chemistry principles in relation to selection of extraction technique.

**Identification methods** will cover:

- The emphasis will be on mass spectrometry and hyphenated chromatographic-spectroscopic techniques;
- Complementary techniques including bases of following spectroscopic methods UV-VIS, IR, RAMAN, and NMR;
- Hands on application of different mass analysers in mass spectrometry and interpretation of mass spectra.

**Case study:** each candidate will be, according to the subject of her/his PhD, given a case study, where she/he will, based on the knowledge gained within this course, evaluate the options and propose the most appropriate separation and identification method.

#### Temeljni literatura in viri / Readings:

##### Knjige / Books:

- D.A. Skoog, D.M. West, F.J. Holler: Fundamentals of Analytical Chemistry, Thomson, Brooks and Cole, Forth Worth, 9th Edition, 2014.
- D.A. Skoog, D.M. West, F.J. Holler: Principles of Instrumental Analysis, Thomson Learning, 7th edition, 2016.
- J. McMurry: Organic Chemistry, Brooks Cole Publishing Company, 9th Edition, 2015.
- K. Robards, P.R. Haddad, P.E. Jackson: Principles and Practice of Modern Chromatographic Methods, Burlington Elsevier Science, 2012.

##### Revije / Periodicals:

- Journals related analytical chemistry / revije s področja analize kemije (Analytical Chemistry, Analytica Chimica Acta, Microchimica Acta, Journal of Chromatography A, Talanta)
- Journals related to environmental sciences / revije s področja okoljskih znanosti (Environmental Science and Technology, Environmental Pollution, Water Research, Science of the Total Environment, Chemosphere, Environmental Research)

##### Pregledni članki, izbor v tekočem letu / Review articles (annual selection)

#### Cilji in kompetence:

**Cilji** predmeta so razumevanje osnov analiznih metod, ki se uporabljajo v organski analizi. V okviru predmeta bomo študentom zagotovili tako poglobljeno poznavanje teorije in instrumentacije s področja separacije in kvalitativne ter kvantitativne

#### Objectives and competences:

The course **objective** is to contribute towards understanding the basic analytical methods applied in organic analysis. We will provide the students with a comprehensive introduction to analytical chemistry techniques as well as knowledge of

določitve organskih spojin, kakor tudi potrebno znanje za samostojno analizo rezultatov spektroskopskih meritev. Zato bo poleg predavanj in seminarjev pomemben del predmeta predstavljalo tudi individualno delo na primerih.

**Specifični cilji predmeta** so uvesti študenta v osnove:

- ocene primernosti razpoložljivih separacijskih tehnik,
- izbira najbolj primerne separacijske tehnike,
- ocena razpoložljivih metod za določitev izbranih spojin,
- izbira najprimernejše metode za kvalitativno in kvantitativno določitev izbranih spojin,
- interpretacija kromatografskih in spektrometričnih podatkov («hands on«).

**Specifični cilji »case study«:**

- izbrati primer organskega onesnaževala in matrice za »case study«,
- izbrati primerno separacijsko tehniko in metodo določitve izbrane spojine v izbrani matrici,
- integrirati interpretacijo kromatogramov in masnih spektrov v kvalitativno in kvantitativno določitev organskih spojin.

**Kompetence:**

- integracija teoretičnega in praktičnega znanja iz organske analize pri reševanju praktičnih primerov.

instrumentation. Besides lectures and seminars, an important part of this course will be devoted to practical exercise, where the students will gain experience in solving analytical problems.

**Specific course objectives** are to introduce students to the basis of:

- Evaluation of available separation techniques;
- Selection of the optimal separation technique;
- Evaluation of available methods for determination of selected organic compound;
- Selection of the optimal method for determination of selected organic compound;
- Hands-on interpretation of chromatographic and spectroscopic data.

**Specific case study objectives** are to:

- Select an organic pollutant and environmental matrix as a case study;
- Select the separation and identification technique for selected pollutant analysis based on theoretical part of exam;
- Integrate chromatograms and mass spectra interpretation into compound qualitative and quantitative determination.

**Competences:**

- Integrate theoretical and practical knowledge on organic analysis in practice.

**Predvideni študijski rezultati:**

- Poznavanje in razumevanje osnov različnih separacijskih metod, ki se pogosto uporabljajo v organski analizi. Poudarek bo na kromatografskih metodah kot so plinska in tekočinska kromatografija.
- Poznavanje in razumevanje osnov kvalitativne in kvantitativne določitve analitov, ki bodo zajemale osnove spektroskopskih metod s poudarkom na masni spektrometriji in praktičnem reševanju spektrov.
- integracija pridobljenega znanja pri reševanju problemov, povezanih s kandidatovim podiplomskim študijem.

**Intended learning outcomes:**

- Knowledge and understanding of fundamentals of the different separation techniques commonly used in organic analysis. The focus will be on chromatographic methods, e.g. gas/liquid chromatography.
- Knowledge and understanding of fundamentals of analyte detection, where students will learn about advanced spectroscopic methods, with the emphasis being on mass spectrometry and hands-on interpretation of mass spectra.
- Integration of obtained skills in solving the problems related to the topic of candidate postgraduate studies.

**Metode poučevanja in učenja:**

Študentje bodo:

- imeli 10 ur predavanj na temo osnovnih separacijskih in detekcijskih tehnik,
- imeli 25 h vaj (praktično reševanje kromatogramov in spektrov),
- pripravili in predstavili seminarsko delo iz izbrane vsebine, ki bo povezovala znanje, pridobljeno v okviru predmeta, in njihovo raziskovalno delo.

**Learning and teaching methods:**

Students will be offered:

- 10 h of lectures on basic separation and detection techniques
- 25 h of exercises (hands-on interpretation of chromatographic and spectroscopic data)
- Preparation and presentation of seminar on a selected topic that will bridge knowledge gained on the course and their research work.

<b>Načini ocenjevanja:</b>	<b>Delež (v %) / Weight (in %)</b>	<b>Assessment:</b>
Seminar	50%	Seminar
Predstavitev	50%	Presentation

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

ČESEN, Marjeta, LENARČIČ, Kaja, MISLEJ, Vesna, LEVSTEK, Meta, KOVAČIČ, Ana, CIMRMANČIČ, Bernardka, URANJEK ŽEVART, Nataša, **KOSJEK, Tina**, HEATH, David John, SOLLNER DOLENC, Marija, **HEATH, Ester**. The occurrence and source identification of bisphenol compounds in wastewaters. *Science of the Total Environment*, 2018, 616-617, 744-752.

COVACI, A., HORVAT, M., **HEATH, E.**, **KOSJEK, T.**, MAZEJ, D., SNOJ TRATNIK, J., et al. Urinary BPA measurements in children and mothers from six European member states: overall results and determinants of exposure. *Environmental Research*, 2015, 141, 77-85.

**KOSJEK, Tina**, NEGREIRA, Noelia, **HEATH, Ester**, LOPEZ DE ALDA, Miren, BARCELÓ, Damià. Aerobic activated sludge transformation of vincristine and identification of the transformation products. *Science of the total environment*, ISSN 0048-9697, 2017, vol. 610/611, str. 892-904.

**KOSJEK, Tina**, NEGREIRA, Noelia, **HEATH, Ester**, LOPEZ DE ALDA, Miren, BARCELÓ, Damià. Biodegradability of the anticancer drug etoposide and identification of the transformation products. *Environmental science and pollution research international*, ISSN 0944-1344.

**KOSJEK, Tina**, PERKO, Silva, ŽIGON, Dušan, **HEATH, Ester**. Fluorouracil in the environment : analysis, occurrence, degradation and transformation. *Journal of chromatography. A*, ISSN 0021-9673, 2013, vol. 1290, str. 62-72