

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Meritve nanodelcev v zraku
Course title:	Measurement of Nanoparticles in Air

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 rd cycle	/	1	1

Vrsta predmeta / Course type Izbirni / Elective

Univerzitetna koda predmeta / University course code: ST3-534

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. Maja Remškar

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

- Izvori nanodelcev v ozračju in njihove specifične lastnosti.
- Detekcijske metode nanodelcev v ozračju, načini vnosa nanodelcev v organizem in posledice za zdravje ter tehnike izločanja nanodelcev iz ozračja.
- Prepoznavanje akutnih in kroničnih virov onesnaženosti z nanodelci, razlika med onesnaženostjo z mikronskimi delci (PM10, PM2.5) in nanodelci.
- Regulativa v nastajanju na tem področju, priporočila za varno delo z nanomateriali in

Content (Syllabus outline):

- Origins of nanoparticles in atmosphere and their specific properties.
- Methods for detection of nanoparticles in atmosphere, entering paths into organism and influence on health, and techniques for removal of nanoparticles from atmosphere.
- Identification of acute and chronic sources of pollution by nanoparticles, the difference between the atmospheric particles in micron size (PM10, PM2.5) and nanoparticles.
- Relevant regulations in preparation, recommendations for safe handling of nanomaterials and the criteria for assessing the

merila za ocenjevanje tveganj pri proizvodnji nanomaterialov oz. ob uporabi nanomaterialov.

- Izvedba meritev v realnem okolju po dogovoru in priprava poročila o analizi.

risks during production of nanomaterials and their use.

- Measurements in a real environment, which will be agreed upon, and preparation of the analysis report.

Temeljni literatura in viri / Readings:

- J.H. Vincent: Aerosol Sampling, Science, Standards, Instrumentation and Applications, J.Wiley&Sons, Chichester 2007. (textbook)
- W.C. Hinds: Aerosol Technology, Properties, Behavior, and Measurement of Airborne Particles, J.Wiley&Sons, Chichester 1999. (textbook)
- Health Council of the Netherlands. Working with nanoparticles: Exposure registry and health monitoring. The Hague: Health Council of the Netherlands, 2012; publication no. 2012/31E. ISBN 978-90-5549-929-8

Cilji in kompetence:

Cilji:

- zagotoviti varno delo z nanomateriali,
- odpreti nova področja razvoja tehnik za odstranjevanje nanodelcev iz ozračja in za preprečevanje njihovih izpustov pri mehanski in toplotni obdelavi materialov.

Kompetence:

- sposobnost razpoznavanja virov onesnaževanja zraka z nanodelci,
- sposobnost vodenja aktivnosti pri izboljševanju delovnih pogojev in varovanju okolja.

Objectives and competences:

Objectives:

- to ensure safe handling of nanomaterials,
- to open up new areas of development of techniques for the removal of nanoparticles from the atmosphere and prevention of release upon mechanical and thermal treatment of materials.

Competences:

- ability to identify different sources of air pollution with nanoparticles,
- ability to conduct activities for improvement of working conditions and environmental protection.

Predvideni študijski rezultati:

Znanje in razumevanje:

- poznavanje specifičnih lastnosti nanodelcev, načinov vstopa v organizem in njihove interakcije s celičnimi linijami in organizmi,
- poznavanje metod za določanje številske porazdelitve nanodelcev v atmosferi in njihove kemijske analize,
- vključevanje priporočil za varno delo z nanomateriali v delo v laboratoriju ali v proizvodnji,
- znanje o merilih za ocenjevanje tveganj pri proizvodnji nanomaterialov oz. ob uporabi nanomaterialov,
- znanje na področju regulative in zakonodaje,
- nove tehnološke rešitve na področju odstranjevanja nanodelcev iz ozračja oz.

Intended learning outcomes:

Knowledge and understanding:

- knowledge on the specific properties of nanoparticles, methods of entry of nanoparticles into the organism and their interactions with cell lines and organisms,
- knowledge on the methods for the determination of the numeric distribution of nanoparticles in the atmosphere and their chemical analysis,
- integration of recommendations for safe handling of nanomaterials at work in the laboratory or in production,
- knowledge on the criteria for assessing the risks of nanomaterials and production during use of nanomaterials,
- knowledge of regulations and legislation,
- new technological solutions for the removal of nanoparticles from the atmosphere and for

preprečevanju njihovega sproščanja pri mehanski ali termični obdelavi materialov.

preventing their release during mechanical or thermal processing of materials.

Metode poučevanja in učenja:

Interaktivna predavanja in konzultacije.
Izvedbe monitoringa na konkretni lokaciji po dogovoru.
Seminar, na katerem bo kandidat (-ka) predstavil-a izsledke monitoringa in predloge za izboljšanje razmer.

Learning and teaching methods:

Interactive lectures and consultations.
Monitoring performance on an agreed specific location.
Seminar, wherein the candidate will present the results of monitoring and suggestions to improve the situation.

Delež (v %) /

Načini ocenjevanja:

Weight (in %)

Assessment:

Monitoring na izbrani lokaciji.	20 %	Monitoring at the selected field.
Seminarska naloga s predstavitvijo.	30 %	Seminar with its presentation.
Ustno izpraševanje.	50 %	Oral examination.

Reference nosilca / Lecturer's references:

- M. Remskar: Nanodelci in nanovarnost / Nanoparticles and Nanosafety, Ministrstvo za zdravje, Urad RS za kemikalije; 2009; http://www.kemijskovaren.si/files/nano_knjiga.pdf
- Remškar Maja, Iskra Ivan, Viršek Marko, Pleško Mark, Golob Damjan: Metoda in kapacitivnostni senzor za štetje aerosolskih nanodelcev/ Method and capacitive sensor for counting aerosol nanoparticles (Urad RS za intelektualno lastnino, patent SI 22895 A)
- Iskra, A. Detela, M. Viršek, V. Nemanič, D. Krizaj, D. Golob, J.T. van Elteren, M. Remskar: Capacitive-type counter of nanoparticles in air. Appl. Phys. Lett. 96 (2010) 093504-1-093504-3.
- R. Nass, M.Remskar, W. Luthar, et al., Industrial application of nanomaterials - chances and risks : technology analysis, (Future technologies, no. 54). Düsseldorf: Future Technologies Division of VDI Technologiezentrum, 2004. 112 p., ilustr.
- Safe Production and Use of Nanomaterials, NANOSAFE2, 6Th FP, Integrated project; 2005-2009 No.: 515843-1.