

UČNI NAČRT PREDMETA / COURSE SYLLABUS

Predmet:	Strategije nadzora radioaktivnosti v okolju z oceno vplivov
Course title:	Strategies of Environmental Radioactivity Monitoring with the Dose Assessment

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

Vrsta predmeta / Course type Izbirni / Elective

Univerzitetna koda predmeta / University course code: EKO3-907

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. Benjamin Zorko

Jeziki / Languages:	Predavanja / Lectures:	slovenščina, angleščina Slovenian, English
	Seminar:	Angleščina, English

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 s področja fizike, kemije, biologije in radio-analiznih metod (pisna dokazila, pogovor).

Prerequisites:

Completed second cycle studies in natural sciences or engineering or completed second level studies in other fields with proven knowledge of physics, chemistry, biology or radio-analytical methods is needed (certificates, interview).

Vsebina:

- Varstvo pred ionizirajočim sevanjem (prebivalstvo, biota) - generični koncepti
 - Razvrstitev vrst izpostavljenosti pred ionizirajočim sevanjem (IS)
 - Načela varstva pred IS
 - Odgovornosti za varstvo IS
 - Stopnjevan pristop
- Varstvo pred ionizirajočim sevanjem za ljudi in bioto v različnih situacijah izpostavljenosti
- Zakonodaja na področju radioaktivnih izpustov
 - Odobritev izpustov
 - Dokazovanje skladnosti
 - Mejne doze in avtorizirane dozne ograde
- Zakaj potrebujemo nadzor radioaktivnosti v okolju (NRO)?
 - zakonodaja EU
 - Pravne zahteve
 - Tehnična priporočila
 - Nadzor radioaktivnosti okolja v EU
- Različne vrste NRO s posebnimi odgovornostmi
 - Elementi programa nadzora
 - Oblikovanje programa nadzora
 - Strategije vzorčenja
 - Analitične metode
- Razlaga in poročanje o rezultatih meritev in drugih podatkov programa nadzora
- Ocena vplivov pri NRO za različne vrste izpostavljenosti (ljudje, biota)
- Izredni monitoring radioaktivnosti in vzdrževanje pripravljenosti za izredni monitoring radioaktivnosti
- Zagotavljanje kakovosti pri NRO
- Vključevanje deležnikov v NRO
- Pregled NRO

Content (Syllabus outline):

- Radiation protection of the public and biota (non-human) – generic concepts
 - Classification of exposure situations
 - Radiation protection principles
 - Responsibilities for radiation protection
 - Graded approach
- Radiation protection of the public and biota in different exposure situations
- Regulatory control of radioactive discharges
 - Authorization of discharges
 - Demonstrating compliance
 - Dose limits and constraints
- Why do we need environmental radioactivity monitoring (ERM)?
 - EU legislation
 - Legal requirements
 - Technical recommendations
 - ERM in EU
- Different types of ERM with specific responsibilities
 - Elements of the ERM programme
 - Design of the ERM programme
 - Sampling strategies
 - Analytical methods
- Interpretation and reporting of monitoring data
- Dose assessment in ERM for different exposure situations (human, non-human), but emergency exposure situation
- Emergency preparedness and response for nuclear or radiological emergency
- Quality assurance in the ERM
- Stakeholder involvement in the ERM
- Review of the ERM

Temeljni literatura in viri / Readings:

- L'Annunziata, Michael F., Handbook of radioactivity analysis, Third Edition, Academic Press, 2012
- Van der Stricht, Etienne, Kirchmann, Rene, Radioecology, Fortemps, Belgium, 2001
- European Commission recommendation on standardized information on radioactive airborne and liquid discharges into the environment from nuclear power reactors and reprocessing plants in normal operation. Euratom Off. J. Eur. Union., 2004, pp L2:32
- International Atomic Energy Agency, Generic Models for Use in Assessing the Impact of Discharges of Radioactive Substances to the Environment, IAEA Safety Reports Series No. 19, Vienna, 2001
- Treaty establishing the European Atomic Energy Community (Euratom)

- International Atomic Energy Agency, Generic Models for Use in Assessing the Impact of Discharges of Radioactive Substances to the Environment, IAEA Safety Reports Series No. 19, Vienna, 2001
- International Atomic Energy Agency, Safety Standard Series, No. GSR Part 7: Preparedness and Response for a Nuclear or Radiological Emergency, Vienna, 2015
- International Atomic Energy Agency, Safety Standard Series, No. GSR Part 3: Radiation Protection and Safety of Radiation Sources: International BSS, Vienna, 2014
- International Atomic Energy Agency, Safety Guide, No. RS-G-1.8: Environmental and Source Monitoring for Purposes of Radiation Protection, Vienna, 2005
- International Atomic Energy Agency, General Safety Guide, No. GSG-2: Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency, Vienna, 2011
- International Atomic Energy Agency, Safety Guide, No. GS-G-2.1: Arrangements for Preparedness for a Nuclear or Radiological Emergency, Vienna, 2007
- Decree on dose limits, radioactive contamination and intervention levels (UV2), Ur. l. RS 18/2018, 2819, 20. 3. 2018
- International Atomic Energy Agency, General Safety Guide, No. GSG-8: Radiation Protection of the Public and the Environment, Vienna, 2018
- National emergency response plan for nuclear and radiological accidents, http://www.sos112.si/eng/tdocs/plan_nuclear_radiological.pdf
- Actions to protect the public in an emergency due to severe conditions at a light water reactor, EPR-NPP PUBLIC PROTECTIVE ACTIONS, IAEA 2013
- ICRP Publication 101a, Assessing Dose of the Representative Person for the Purpose of Radiation Protection of the Public and The Optimisation of Radiological Protection: Broadening the Process, Ann. ICRP 36 (3), 2006
- ICRP Publication 124, Protection of the Environment under Different Exposure Situations, Ann. ICRP 43(1), 2014
- ICRP Publication 103, The 2007 Recommendations of the International Commission on Radiological Protection, Ann. ICRP 37, 2007
- ICRP Publication 119, Compendium of Dose Coefficients based on ICRP Publication 60, Ann. ICRP 41, 2012
- IAEA Safety Guide 427, Prospective Radiological Environmental Impact Assessment for Facilities and Activities, Draft safety guide DS427, 2016
- Handbook of Parameter Values for Prediction of Radionuclide Transfer in Terrestrial and Freshwater environment, IAEA TRS no. 472
- International Standards Organization ISO, Guide to the expression of Uncertainty in Measurement, ISBN 92-67-10188-9, Switzerland, 1995
- S. Širca, Verjetnost v fiziki, DMFA – založništvo, Ljubljana 2016
- International Standards Organization ISO 11929:2010 (E). Determination of the characteristic limits (decision threshold, detection limits and limits of confidence interval) for measurements of ionizing radiation-fundamentals and application, ISO, Geneva, 2010
- Ellison, S. L. R., Williams, A. EURACHEM/CITAC guide, quantifying uncertainty in analytical measurement, 3rd edn, 2011, discussion draft 1
- Nadzor radioaktivnosti v okolici Nuklearne elektrarne Krško, Poročilo za leto 2018, IJS-DP-12784, Ljubljana, april 2019
- Charrasse, Benoit, Zorko, Benjamin, et al. Does the use of reference organisms in radiological impact assessments provide adequate protection of all the species within an environment?. Science of the total environment, ISSN 0048-9697, 2019, vol. 658, str. 189-198, doi: 10.1016/j.scitotenv.2018.12.163

Cilji in kompetence:

Glavni cilj predmeta je študentom zagotoviti teoretično in praktično znanje iz različnih poglavij o nadzoru radioaktivnosti v okolju (NRO). Študenti bolje razumejo pomen in uporabnost programov NRO v različnih situacijah izpostavljenosti za ljudi in bioto, vključno z izrednim monitoringom in pripravo na odziv v takšnih primerih.

Študenti razvijejo praktične spretnosti pri določanju strategij v programih NRO, od opredelitve problema, izbire ustreznih spremenljivk do ocene vpliva in interpretacije podatkov. Znajo uporabljati ustrezne postopke za NRO v različnih okoljskih prostorih (nišah) skupaj z ustreznimi programi zagotovitve kakovosti.

Objectives and competencies:

The main objective of the course is to provide students with theoretical knowledge and practical skills in various chapters of environmental radioactivity monitoring (ERM). Students get a better understanding of the importance and usefulness of ERM programmes in different exposure situations for humans and biota including emergency and preparedness response.

Students develop practical skills in setting strategies in ERM from defining a problem, selecting appropriate variables to evaluation and interpretation of the data. They are able to use the appropriate procedures for ERM in various environmental compartments in conjunction with adequate QA programmes.

Predvideni študijski rezultati:

- Pojasni elemente različnih programov nadzora radioaktivnosti v okolju (NRO)
- Upraviči izpolnjevanje regulativnih zahtev za NRO
- Določi strategije vzorčenja in meritev
- Samostojno Interpretira podatke pridobljenih v NRO
- Vrednoti ocene vplivov za različne primere izpostavljenosti ionizirajočemu sevanju (človek, biota)
- Sestavi program NRO na podlagi scenarija
- Pojasni odzive v primerih izrednega monitoringa

Intended learning outcomes:

- Explicate the elements of different environmental radioactivity monitoring (ERM) programmes
- Justify fulfillment of regulatory requirements of ERM
- Set sampling and measurement strategies
- Self-efficacy to interpret data obtained in ERM
- Assess doses for different exposure situations (human, biota)
- Design ERM programme related to a given scenario
- Explicate responses in different emergency situations

Metode poučevanja in učenja:

- Predavanja
- Vaje
- Seminar
- Konzultacije
- Timsko delo in diskusije

Learning and teaching methods:

- Lectures
- Tutorials
- Seminar work
- Consultations
- Team work and discussions

Načini ocenjevanja:

- Ustni izpit
- Seminarska naloga (Zagovor seminarske naloge, pri katerem se dokaže osvojitev (razumevanje) študijskega gradiva na primeru)

Delež (v %) /

Weight (in %)

Assessment:

- Oral Exam
- Seminar work (Defence of the seminar work where the student demonstrate achievements (understanding) of the study programme based on case study)

Reference nosilca / Lecturer's references:

- B. Zorko et al., Obdelava podatkov meritev radioaktivnosti v okolju, ISBN 978-961-264-150-4, Institut "Jožef Stefan", Ljubljana, april 2019
- B. Zorko, M. Korun, J. C. M. Canadas, V. Nicoulaud Gouin, P. Chyly, A. M. Blixt Buhr, C. Lager, K. Aquilonius and P. Krajewski, Systematic influences of gamma-ray spectrometry data near the decision treshold for radioactivity measurements in the environment, *Journal of Environmental Radioactivity*, 158-159 (2016) 119-128
- Masson, O., Zorko, Benjamin. Airborne concentrations and chemical considerationsof radioactive ruthenium from an undeclared majornuclear release in 2017. *Proceedings of the National Academy of Sciences of the United States of America*, ISSN 0027-8424, 2019, 10 str., doi: 10.1073/pnas.1907571116
- Charrasse, Benoit, Zorko, Benjamin, et al. Does the use of reference organisms in radiological impact assessments provide adequate protection of all the species within an environment?. *Science of the total environment*, ISSN 0048-9697, 2019, vol. 658, str. 189-198, doi: 10.1016/j.scitotenv.2018.12.163
- Černe, Marko, Zorko, Benjamin, et al. The effect of stabilization on the utilization of municipal sewage sludge as a soil amendment. *Waste management*, ISSN 0956-053X. [Print ed.], 2019, vol. 94, str. 27-38, doi: 10.1016/j.wasman.2019.05.032.